

**Tarja Tiainen, Hannakaisa Isomäki,
Mikko Korpela, Anja Mursu, Pirkko Nykänen,
Minna-Kristiina Paakki, and Samuli Pekkola (eds.)**

Proceedings of 30th Information Systems Research Seminar in Scandinavia – IRIS30

11.-14.8.2007, Murikka, Tampere, Finland



DEPARTMENT OF COMPUTER SCIENCES
UNIVERSITY OF TAMPERE

D-2007-9

TAMPERE 2007

UNIVERSITY OF TAMPERE
DEPARTMENT OF COMPUTER SCIENCES
SERIES OF PUBLICATIONS D – NET PUBLICATIONS
D-2007-9, SEPTEMBER 2007

**Tarja Tiainen, Hannakaisa Isomäki,
Mikko Korpela, Anja Mursu, Pirkko Nykänen,
Minna-Kristiina Paakki, and Samuli Pekkola (eds.)**

Proceedings of 30th Information Systems Research Seminar in Scandinavia – IRIS30

11.-14.8.2007, Murikka, Tampere, Finland

DEPARTMENT OF COMPUTER SCIENCES
FIN-33014 UNIVERSITY OF TAMPERE

ISBN 978-951-44-7048-6
ISSN 1795-4274

Content

Introduction , Tarja Tiainen	6
Opening and Keynotes	
ON IDEAS BEHIND OF EARLY IRIS SEMINARS, Pertti Järvinen	7
THE NEVER ENDING STORY OF IT IMPACT ON THE ORGANIZATION – THE CASE OF AMBIENT ORGANIZATIONS, Niels Bjørn-Andersen.....	10
A NEW LOOK AT AN OLD PROBLEM: REQUIREMENTS DETERMINATION AND ITS CHALLENGES, Kalle Lyytinen	20
PUTTING THE THEORY BACK INTO GROUNDED THEORY: A MODEL FOR THEORY BUILDING IN INFORMATION SYSTEMS, Cathy Urquhart	21
Best papers	
MODELING TOOL FOR DESIGNING USABLE MOBILE SERVICES, Heli Wigelius, Anne Aula, and Maiju Markova.....	512
THE LAPTOP AS ALIBI, Tomas Lindroth.....	124
CHANGING LARGE-SCALE COLLABORATIVE SPACES: STRATEGIES AND CHALLENGES, Torstein Hjelle and Gasparas Jarulaitis	906
A Special Remarkable Paper	
IRIS (1978-2006) HISTORICAL REFLECTION THROUGH VISUAL ANALYSIS, Judith Molka-Danielsen, Matthias Trier, Vadim Shlyk, Annette Bobrik, and Markku I. Nurminen	968
Workshops / Panels	
ON STUDYING SOCIALLY CONSTRUCTED REALITY, Pertti Järvinen	22
Working groups	
Working group Ankkuri - Chair: Karlheinz Kautz	
CULTURAL ASPECTS IN GLOBAL SYSTEMS DEVELOPMENT – AN ANALYTICAL TOOL, Sattar Al-Haydar, Fredrik Karlsson.....	34
MANAGERIAL PERSPECTIVES OF OSS ENACTED CHANGES IN THE FINNISH SOFTWARE INDUSTRY, Juho Lindman.....	49
BALANCING TECHNOLOGICAL AND COMMUNITY INTERESTS: THE CASE OF CHANGING A LARGE OPEN SOURCE SOFTWARE SYSTEM, Thomas Østerlie, Letizia Jaccheri	66
MIGRATION TO OPEN SOURCE OFFICE SUITE, Martti Karjalainen	81
FROM CLOSED SOURCE AND OPEN SOURCE TO SHARED SOURCE: A NEW BUSINESS MODEL FOR INDEPENDENT SOFTWARE VENDORS? Mikko Rieppula	106
Working group Jyrsin - Chair: Sara Eriksen	
THE LAPTOP AS ALIBI, Tomas Lindroth.....	124
MAPPING SERVICE QUALITY - MEASURING AND COMPARING QUALITY OF EXPERIENCE AND QUALITY OF SERVICE FOR INTERNET-BASED MAP SERVICES, C. Eliasson, S. Chevul, M. Fiedler, A. Ekelin, S. Eriksén	139

Working group Kulta – Chair Hannakaisa Isomäki	
ADVERTISING IN UBIQUITOUS MEDIA ENVIRONMENTS, Carina Ihlström Eriksson, Maria Åkesson, Jesper Hakeröd.....	150
ATELIER INFRASTRUCTURE FOR UBIQUITOUS COMPUTING, Antti Juustila, Toni Räisänen.....	169
EXERCISES IN STUDYING USER INTERFACE DESIGN GUIDELINES AND PATTERNS, Ilari Jounila, Mari Nikkanen	187
TECHNOLOGIES, COMMUNITIES AND BROADCASTERS: INVESTIGATING THE USE OF DIGITAL TECHNOLOGIES BY UK ETHNIC MINORITY RADIO BROADCASTERS, John Cawood, Eleanor Shember-Critchley	194
USER SATISFACTION IN AGEING WORKERS’ USE OF INFORMATION SYSTEMS, Kirsi Päykkönen, Hannakaisa Isomäki	210
Working group Kupari - Chair: Peter Axel Nielsen	
REQUIREMENTS ENGINEERING FOR SOFTWARE RECONTEXTUALIZATION, Dorina Gumm, Monique Janneck	226
IMPLICIT REPRESENTATIONS OF USE: SOURCES, POTENTIALS AND RISKS, Sampsa Hyysalo	244
SOFTWARE DEVELOPMENT METHODS AND KNOWLEDGE SHARING, Sari Vesiluoma	262
EXPLAINING SUCCESSFUL INTEGRATION OF A SECURE INFORMATION SYSTEM METHOD INTO AN ORGANIZATION’S ISD PROCESS, Juhani Heikka	279
ASSESSMENT TOOLS AS DRIVERS FOR SPI: SHORT-TERM BENEFITS AND LONG- TERM CHALLENGES, Sune Müller, Jacob Nørbjerg, Hiu Cho	297
Working group Latomo - Chairs: Cathy Urquhart and Samuli Pekkola	
GROUNDING THEORY - THE TWO FACES OF THE METHODOLOGY AND THEIR MANIFESTATION IN ISS RESEARCH, Riitta Hekkala	314
THE NEGOTIATION OF STANDARDS: THE CASE OF THE OPEN MOBILE ALLIANCE, Endre Grøtnes	329
STORY, NARRATIVE AND STORYTELLER IN IS RESEARCH, Thomas Persson Slumpi	346
SOUND FROM THE FIELD: NARRATIVITY TO IS, Irja Tourunen, Samuli Pekkola	364
AN ACTIVITY THEORY BASED FRAMEWORK FOR ENHANCING OF USER ‘CONSCIOUS’ LEARNING IN INFORMATION SYSTEM DEVELOPMENT, Tjongabangwe Selaolo	374
INTEGRATING TRACEABILITY IN QUALITATIVE RESEARCH, Nilay Oza	395
Working group Leka - Chair: Niels Björn-Andersen	
ERP EDUCATION IN THE IS DISCIPLINE – IS THE TREND TOWARDS THE RIGHT DIRECTION? Timo Lainema, Kristian Kiili.....	414
TOWARDS A CONTINGENCY FRAMEWORK FOR ENGINEERING AN ENTERPRISE ARCHITECTURE PLANNING METHOD, Mauri Leppänen, Katariina Valtonen, Mirja Pulkkinen	430
THE ADAPTIVE CAPABILITY LIFECYCLE, Karin Elisabeth Fritzer	450
IDENTIFYING REQUIREMENTS FOR FUTURE ERP SYSTEMS, Björn Johansson, Niels Bjoern-Andersen	467
Working group Masuuni - Chair: Heinz Zuellighoven	
STRATEGIES FOR STANDARDIZATION: THE CASE OF THE MOBILE INDUSTRY, Endre Grøtnes	481
THE ROLE OF PROBLEM MANAGEMENT IN CUSTOMER SUPPORT: A CASE STUDY, Marko Jäntti, Niko Pylkkänen	497
MODELING TOOL FOR DESIGNING USABLE MOBILE SERVICES, Heli Wigelius, Anne Aula, Maiju Markova	512

SERVICE ORIENTED ARCHITECTURE FOR HEALTH INFORMATION SYSTEMS IN AFRICA: ISSUES, LITERATURE AND SYSTEMS SURVEY, AND RESEARCH DIRECTIONS, Boniface Kabosa	532
ADAPTING THE DELONE AND MCLEAN IS SUCCESS MODEL – A PDA IMPACT STUDY IN NORWEGIAN HOME HEALTH CARE, Kari Aasheim	551
Working group Rauta - Chair: Yvonne Dittrich	
UNVEILING THE MYSTERIOUS NEEDS OF USERS, Anna Ståhlbröst, Birgitta Bergvall-Kåreborn	570
SCENARIO PLANNING AND PERSONAS AS AID TO REDUCE UNCERTAINTY OF FUTURE USERS, Erik Borglund, Lena-Maria Öberg	587
A REFLECTIVE PERSPECTIVE ON RESEARCHER INVOLVEMENT IN SOFTWARE DEVELOPMENT, Carina Hallqvist	608
PARTICIPATIVE PROCESS MODELING AS A TRAINING WHEEL, Kaisu Juntunen ..	622
MASS CUSTOMIZATION AND E-TAILING: IMPLICATIONS TO VIRTUAL FURNITURE MASS CUSTOMIZATION, Taina Kaapu; Kyösti Pennanen	641
Working group Ruori - Chair: Dick Stenmark	
KNOWLEDGE TRANSFER ACROSS BOUNDARIES IN E-LEARNING, A SOLUTION PROPOSAL, Erkki Koponen	655
WAS IT POD WORTHY? Anna Wingkvist, Jason Alexander	674
MULTIMEDIA INSTRUCTION IN WORK-INTEGRATED E-LEARNING, Christian Östlund, Lars Svensson, Karlheinz Kautz	683
ONE FOR ALL, AND ALL FOR ONE? Dick Stenmark, Henrik Strindberg	699
Working group Sinkki - Chair: Knut Rolland	
INFORMATION SPECIFICITY IN THE CONTEXT OF MEDICATION INFORMATION: A CONCEPTUAL ANALYSIS, Eeva Aarnio, Reetta Raitoharju	717
BEYOND STUDENT AND TECHNOLOGY: SEVEN PIECES TO COMPLETE THE E-LEARNING JIGSAW PUZZLE IN DEVELOPING COUNTRIES, Annika Andersson	731
TOWARD PLANNED CHANGES: AN ACTIVITY-DRIVEN ISD MODEL, Irmeli Luukkonen, Marika Toivanen, Anja Mursu	752
Working group Sorvi - Chair: Mikko Ruohonen	
TOWARDS AN UNDERSTANDING OF TRUST IN B2C E-SERVICE RELATIONSHIPS, Matti Mäntymäki	774
CONCEPTUAL MODELS FOR DATA QUALITY RESEARCH, Retha de la Harpe	801
CRITERIA FOR MEASURING AND COMPARING INFORMATION SYSTEMS, Joel Palmius	823
MEASURING THE EFFECTS OF SOA ON BUSINESS – DESCRIPTION OF THE STUDY, Annika Granebring, Cecilia Lindh	847
BUSINESS DOMAIN MODELS AS TOOLS IN DEVELOPMENT OF ENTERPRISE RESOURCE PLANNING SYSTEMS, Signe Ellegård Borch, Renate Kristiansen ..	861
Working group Telakka - Chairs: Brian Fitzgerald and Minna Koskinen	
COMMUNICATION AND INFORMATION EXCHANGE AMONG SMES AND THEIR LOCAL ENVIRONMENT, Viveca Asproth, Christina Nyström	876
THERE AND BACK AGAIN – INQUIRES INTO THE DEVELOPMENT OF A VIABLE ORGANIZATIONAL PARTICIPATORY DESIGN ABILITY, Johan Bolmsten ...	888
CHANGING LARGE-SCALE COLLABORATIVE SPACES: STRATEGIES AND CHALLENGES, Torstein Hjelle, Gasparas Jarulaitis	906
RUNNING CHANGES AND RE-DESIGN IN THE AUTO INDUSTRY: AN EXPLORATORY STUDY OF ENGINEERING AND KNOWLEDGE TRANSFER AFTER START OF PRODUCTION, Amanda Wolgast, Blair E. Carlson	920

TOWARDS AND UNDERSTANDING OF THE ADOPTION MECHANISMS OF ETHNOGRAPHY IN NEW PRODUCT DEVELOPMENT, Markus Lahtinen	938
BOUNDARY ACTORS IN USER-DEVELOPER COMMUNICATION, Minna Koskinen, Anne Pirinen	950
Working group Tina - Chairs: Kalle Lyytinen and Pertti Järvinen	
IRIS (1978-2006) HISTORICAL REFLECTION THROUGH VISUAL ANALYSIS, J. Molka-Danielsen, M. Trier, V. Shlyk, A. Bobrik, M. I. Nurminen	968
HOW TO STUDY THE CONTEXT OF INFORMATION SYSTEMS, Tuija Tiihonen	993
UTILIZING TEXT-MINING TOOLS TO ENRICH TRADITIONAL LITERATURE REVIEWS. CASE: DIGITAL GAMES, Johanna Bragge, Jan Storgårds	1007
VIALE INTRANETS FOR VIALE ORGANIZATIONS – THE SHARED AND COMMON INTRANET, Christina Nyström	1031
EMPOWERMENT AS A FACTOR FOR SUSTAINING THE CONTINUANCE OF AN INFORMATION SYSTEM, Leila Humes, Nicolau Reinhard	1043
Working group Valu - Chair: Per Flensburg	
SOCIAL AND ECONOMIC INCENTIVES IN ONLINE SOCIAL INTERACTIONS: A MODEL AND TYPOLOGY, Nikolaos Korfiatis	1060
BUSINESS VALUE CREATED BY B2B MOBILE SERVICES, Miira Juntumaa	1078
HOW CAN COMPANIES WORK WITH OPEN SOURCE COMMUNITIES FOR OPEN INNOVATION?, Mikko Ahonen, Maria Antikainen, Marko Mäkipää	1091
ECOLLABORATION AND IMPACT ON TASK AND TASK OUTPUT: TEN CASE STUDIES, Anita Mirijamdotter, Katarina Stanoevska-Slabeva	1103
BUILDING COMMITMENT AND TRUST TO ICT COLLABORATION IN PARTNERSHIP NETWORKS, T. Kestilä, M. Mäkipää, H. Salmela, L. Salmivalli	1120
AN ENHANCED COMMUNICATION MODEL, Per Flensburg	1135
Working group Verstas - Chair: Christina Mörtberg	
INFORMATION SYSTEMS AS A MEDIUM FOR IDENTITY EXPRESSION, Anders Henriksen	1145
HIGH SCHOOL STUDENTS - RELATIONSHIP BETWEEN ICT AND PSYCHOSOCIAL LIFE ENVIRONMENT, Ulrika Danielsson	1160
DO I HAVE ENOUGH TIME TO VISIT LIBRARY BEFORE MY BUS ARRIVES? – EXPLORING COMPATIBILITY AND SPATIAL INTERACTION IN TECHNOLOGY ACCEPTANCE, Teija Vainio, Ilari Karppi, Pauliina Lehtonen .	1179
THE QUESTION OF RESPONSIBILITY FOR LONG-TERM DIGITAL PRESERVATION, Mari Runardotter, Anita Mirijamdotter, Christina Mörtberg	1195
NATIONAL ENTERPRISE ARCHITECTURES IN THE SCANDINAVIAN COUNTRIES, Katja Liimatainen	1213
COMPETENCE MANAGEMENT SYSTEMS IN NETWORKING ORGANISATIONS: DESIGNING FOR EMPOWERMENT? Ulrika Lundh Snis, Lena Pareto, Lars Svensson	1236
Working group Viila - Chair: Markku I Nurminen	
PHYSICIANS' VIEWS TOWARD MOBILE HIS, Katja Leiviskä	1249
EHEALTH: VITALISTIC AND SAPPING SYSTEMS, Walter Uys	1263
DESIGNING OUR WAY TO USER UNDERSTANDING, Johann van der Merwe	1284
ORGANIZATIONAL IMPLEMENTATION IN CRISIS: THE ROLE OF THE INFORMATION SYSTEM, Anne Forsell, Helena Karsten, Riikka Vuokko	1300
DECONSTRUCTION OF MEDICATION RELATED SERVICES AND RECONSTRUCTING THE MANAGEMENT OF PERSONAL HEALTH INFORMATION, Pekka Muukkonen, Markku I. Nurminen	1313

Index by authors (name and page)

- Aarnio, Eeva, 717
 Aasheim, Kari, 551
 Ahonen, Mikko, 1091
 Alexander, Jason, 674
 Al-Haydar, Sattar, 34
 Andersson, Annika, 731
 Antikainen, Maria, 1091
 Asproth, Viveca, 876
 Aula, Anne, 512
 Bergvall-Kåreborn, Birgitta, 570
 Björn-Andersen, Niels, 10, 467
 Bobrik, Annette, 968
 Bolmsten, Johan, 888
 Borglund, Erik, 587
 Bragge, Johanna, 1007
 Carlson, Blair E., 920
 Cawood, John, 194
 Chevul, Stefan, 139
 Cho, Hiu, 297
 Danielsson, Ulrika, 1160
 de la Harpe, Retha, 801
 Ekelin, Annelie, 139
 Eliasson, Charlott, 139
 Ellegård Borch, Signe, 861
 Eriksen, Sara, 139
 Fiedler, Markus, 139
 Flensburg, Per, 1135
 Fritzer, Karin Elisabeth, 450
 Forsell, Anne, 1300
 Granebring, Annika, 847
 Grøtnes, Endre, 329, 481
 Gumm, Dorina, 226
 Hakeröd, Jesper, 150
 Hallqvist, Carina, 608
 Heikka, Juhani, 279
 Hekkala, Riitta, 314
 Henriksen, Anders, 1145
 Hjelle, Torstein, 906
 Humes, Leila, 1043
 Hyysalo, Sampsa, 244
 Ihlström Eriksson, Carina, 150
 Isomäki, Hannakaisa, 210
 Jaccheri, Letizia, 66
 Janneck, Monique, 225
 Jarulaitis, Gasparas, 906
 Johnsson, Björn, 467
 Jounila, Ilari, 187
 Juntumaa, Miira, 1078
 Juntunen, Kaisu, 622
 Juustila, Antti, 150
 Jäntti, Marko, 497
 Järvinen, Pertti, 7, 22
 Kaapu, Taina, 641
 Kabosa, Boniface, 532
 Karjalainen, Martti, 81
 Karlsson, Fredrik, 34
 Karppi, Ilari, 1179
 Karsten, Helena, 1300
 Kautz, Karlheinz, 683
 Kestilä, Timo, 1120
 Kiili, Kristian, 414
 Koponen, Erkki, 655
 Korfiatis, Nikolaos, 1060
 Koskinen, Minna, 950
 Kristiansen, Renate, 861
 Lahtinen, Markus, 938
 Lainema, Timo, 414
 Lehtonen, Pauliina, 1179
 Leiviskä, Katja, 1249
 Leppänen, Mauri, 430
 Liimatainen, Katja, 1213
 Lindh, Cecilia, 847
 Lindman, Juho, 49
 Lindroth, Tomas, 124
 Lundh Snis, Ulrika, 1236
 Luukkonen, Irmeli, 752
 Lyytinen, Kalle, 20
 Markova, Maiju, 512
 Mirijamdotter, Anita, 1103, 1195
 Molka-Danielsen, Judith, 968
 Muller, Sune, 297
 Mursu, Anja, 752
 Muukkonen, Pekka, 1313
 Mäkipää, Marko, 1091, 1120
 Mäntymäki, Matti, 774
 Mörtberg, Christina, 1195
 Nikkanen, Mari, 187
 Nurminen, Markku I., 968, 1313
 Nyström, Christina, 876, 1031
 Nörbjerg, Jacob, 297
 Oza, Nilay, 395
 Palmius, Joel, 823
 Pareto, Lena, 1236
 Pekkola, Samuli, 364
 Pennanen, Kyösti, 641
 Persson Slumpi, Thomas, 346
 Pirinen, Anne, 950
 Pulkkinen, Mirja, 430
 Pylkkänen, Niko, 497
 Pyykkönen, Kirsi, 210
 Raitoharju, Reetta, 717
 Reinhard, Nicolau, 1043
 Rieppula, Mikko, 106
 Runardotter, Mari, 1195
 Räisänen, Toni, 187
 Salmela, Hannu, 1120
 Salmivalli, Lauri, 1120
 Selaolo, Tjongabangwe, 374
 Shember-Critchley, Eleanor, 194
 Shlyk, Vadim, 968
 Stanoevska-Slabeva, Katarina, 1103
 Stenmark, Dick, 699
 Storgårds, Jan, 1007
 Strindberg, Henrik, 699
 Ståhlbröst, Anna, 570
 Svensson, Lars, 683, 1236
 Tiainen, Tarja, 6
 Tiihonen, Tuija, 993
 Toivanen, Marika, 752
 Tourunen, Irja, 364
 Trier, Matthias, 968
 Urquhart, Cathy, 21
 Uys, Walter, 1263
 Vainio, Teija, 1179
 Valtonen, Katariina, 430
 van der Merwe, Johann, 1284
 Vesiluoma, Sari, 262
 Wigelius, Heli, 512
 Wingkvist, Anna, 674
 Wolgast, Amanda, 920
 Vuokko, Riikka, 1300
 Åkesson, Maria, 150
 Öberg, Lena-Maria, 587
 Østerlie, Thomas, 66
 Östlund, Christian, 683

Introduction

Tarja Tiainen

University of Tampere, Finland

tarja@cs.uta.fi

This is the proceedings of the 30th Information Systems Research Seminar in Scandinavia (IRIS) conference (at 11.-14.8.2007 at Murikka, Tampere, Finland). The history of IRIS is unusual long in the information systems field. IRIS started at Tampere and now it is back here again. During the rounds in Scandinavian, the conference has grown and advanced. Still the main idea is the same: to support novice researchers to develop in writing research papers. This is done by presenting working papers and discussing about them in small groups.

The themes of IRIS30 are Models, Methods and new Messages. IRIS30 includes both traditional subjects in IS research (as methods for reaching requirement in Kalle Lyytinen's keynote) and new emerging issues (as in Niels Björn-Andersen's keynote about organizing work in the age of Internet and other knowledge mobilization technologies). Furthermore, the fundamental issue of all disciplines – how research is done – is dealt with (for example, in Cathy Urquhart's keynote about grounded theory). The proceedings include the whole paper by Björn-Andersen and the abstracts of Lyytinen's and Urquhart's keynote.

In IRIS30 the number of participants was high. IRIS30 included 16 working groups – each of them includes six papers. IRIS30 participants came from Scandinavia (Finland, Denmark, Norway, and Sweden) and other European countries (England, France, German, Ireland, and Netherland). While there were also participants outside of Europe (Brazil, Botswana, Nigeria, Mozambique, and South Africa) and the keynote speakers from Denmark, USA, and New Zealand, IRIS30 was really an international conference.

The proceedings include only the papers which authors give a permission to publish it in the series of Computer Sciences at University of Tampere. The proceedings consist on 77 papers which are presented and discussed in the working groups. Besides of the keynotes and papers of working groups, the proceedings include opening speech by Pertti Järvinen, the best papers, and a panel paper. The proceedings is organized by the program of IRIS30. First, there are the opening speech and the keynotes, then the best papers and finally the working group papers, which are organized on the base of their working groups. Furthermore, the proceedings have an index by the authors' name.

On ideas behind of early IRIS seminars

Pertti Järvinen

University of Tampere, Finland

pj@cs.uta.fi

The main reason to invite the first meeting of the Scandinavian research seminar in information systems (the IRIS abbreviation was invented in the 10th seminar), was *the shortage of supervisory capacity*. The senior researchers in Information Systems were looking at many-sided requests presented by their junior colleagues concerning knowledge about their research interest areas. Every senior researcher admitted that she or he was not competent to advise all her or his junior colleagues. But all the seniors were not working at the same domain, and hence they could co-operate, and the juniors could also help each others. To this end and based on the initiative made by prof. Pentti Kerola we decided to come together 1978. For practical reasons Tampere was selected to the place. Prof. Mats Lundeberg and Göran Goldkuhl were invited from Sweden.

In order to become aware about our competence areas we decided that everybody must prepare her or his own paper, which will be long discussed in the working groups. One idea was to transmit knowledge among participants, e.g., who is expert on a certain area. Another idea was to support the further development of the paper. The ultimate goal was to improve the paper to become qualified as a conference or even journal paper.

To analyze our starting points, first, as I understand, for senior researchers, especially for professors, it is difficult to admit that she or he does not know everything – we professors are omnipotent! But many of us, at least the oldest ones, had worked in industry before coming into academia. Also the Scandinavian long traditions in democracy might have an influence on positive prerequisites for co-operation.

Another reason to alleviate hindrances of co-operation was the newness of our discipline. All our universities are government owned and national governments were eager to install new vacancies on IT and Information Systems. Hence, there was not much competition on posts among few potential candidates, because salaries in industry were then as now higher than in academia. This also encouraged co-operation.

In addition to the Scandinavian democratic tradition, every participant had then and has also now some own special competence area. We can learn from each others. The requirement that every participant must prepare her or his own paper supported equality among participants and at the same moment reduced unnecessary hierarchy, especially social hierarchy which can sometimes hinder mutual exchange of ideas and views.

In order to theorize what we have done for many years. Somebody can be a member of the steering committee for a certain period, four years. The same is true with the members of editorial board. Nobody is irreplaceable, but the responsibility is circulating in all the activities needed: organizing IRIS conferences, managing Scandinavian Journal of Information Systems and guiding other matters. Hence, we try to eliminate unnecessary competition, and reduce unnecessary hierarchy wherever it could appear, and this is done for supporting co-operation.

To relate our way to discuss in working groups to the motivators discovered Herzberg already late 1950s, we can recall that his list of six motivators was: 1. achievements, 2. recognition, 3. responsibility, 4. advancement, 5. growth in competence and 6. work as such. In discussions of our paper in a working group we can at best receive such a feedback that we can receive experiences on our achievement, advancement and growth in competence, other group members will recognize us. Hence our research work has been valuable and important, and we can feel to be responsible for a particular research domain. All the motivators can be satisfied in our working groups, it only depends on us as participants, how do we behave and meet our colleagues, our group members.

Galperin identified 5 development sectors of human being: a) intellectual, b) social, c) polytechnical, d) expressional and e) physical. In working groups we can apply our intellectual capabilities, we should be social, we can express ourselves both verbally, orally and by using body language. Concerning polytechnical matters, which mean all kinds of skills, we can apply our foreign language skills in discussions. But we cannot much apply our physical capabilities in the IRIS working groups. Therefore IRIS games are important. We did not have the traditional IRIS games from the beginning, but we went to exercise jogging and after that to sauna. According to feedback I received some participants in IRIS seminars started their continuous physical training. I should also mention two exceptional acts: Pekka Tyllilä went by bicycle from Tampere to Århus and back for the 8th IRIS, and Arild Jansen did the same from Alta to Turku and back for 13th IRIS, they are real heroes. To my mind, the IRIS games also have an important socializing and familiarizing functions that are in line with the main purposes of the IRIS.

When we consider the publication activity, our submission of the article to a certain journal means that our article will participate in the competition among the

best researchers in the world. Our submission to the IRIS conference means that, if our paper is inside of the IRIS field, it will be accepted for presentation and discussion in a working group. Hence, prof. Karl-Heinz Kautz crystallized one of the ideas of the IRIS as follows: a junior scientist will publish her first article in the IRIS. Do we need the IRIS in the future? My strong belief is that we need. It is the safe and comfortable place for a junior scientist to publish her or his first paper. For us, for senior scientists, the IRIS is the arena where we can meet in the friend atmosphere, discuss about all issues and help each others. The original reason, the shortage of supervisory capacity, is not disappeared. On the contrary, Information Systems have divided into even more sub-topics and we cannot master everything. It seems to me that we can well enough master an even smaller, narrower domain of our discipline.

Hence, I can with good reasons recommend that in this and next IRIS conferences we could reduce unnecessary hierarchy, eliminate unnecessary competition and maintain friendly democratic atmosphere. Vivat, crescat, floreat our common IRIS!

The Never Ending Story of IT Impact on the Organization – The Case of Ambient Organizations¹

Niels Bjørn-Andersen

Center for Applied Information and Communication Technologies, Copenhagen Business School, Denmark

nba@cbs.dki

1. Introduction

Since the early introduction of IT² into organizations, practitioners and researchers have been intrigued by the issues about the impact of IT on individuals (Hoos 1960, Mumford & Banks, 1967) and organizations (e.g. Whisler, 1970). The tremendous and on most dimensions accelerating advances in the technology over the last 50 years has not decreased this interest in how this technology is contributing to changes in individuals roles, organizational structures/processes, and industry structures.

In this paper we shall first provide an overview of what we see as the dominating research perspective on this development over the last four decades, where the focus has shifted from organizational impact and organizational design in the 70'ies and 80'ies, to inter-organizational design in the 90'ies and more recently to organizational re-invention in this decade.

Secondly, we shall proceed to argue that the technological development is not reaching a plateau or coming to an end. On the contrary, it likely that we shall see an even stronger growth in the development on a number of dimensions, which potentially will have huge impact on the way in which organizations will find it is most advantageous to organize. Accordingly, we shall expect to see even more important changes over the next decade. This has been extensively analyzed among other

¹ IT is defined broadly as covering all types of IT and telecommunication technologies

places in the relevant EU research committees, most notably the ISTAG committee (2001), focusing on what they call Ambient Intelligence and Ambient Technologies.

Thirdly, we will proceed to speculate how these new developments will pave the way for a new type of organizations that we have chosen to call the “Ambient Organization”. The concept will be discussed, and different definitions will be analyzed as a basis for our definition.

Fourthly, we shall illustrate the term by looking at business processes like innovation, production, marketing and after sales service, where existing companies already today are acting like ambient organizations.

The paper will conclude with the prediction that we have not reached the end of the IT-induced changes in organizational structures. In the word of Churchill, we are only at the end of the beginning. We have only started to grasp the enormous potential of the technology to create new and even more effective organizations. Accordingly, the question raised in the title of the famous article by Donald Coase (Nobel prize winner in 1991) “Why do we have organizations”, is likely to require a totally new answer in a foreseeable future. Maybe we will not have organizations like we use to know them?

2. Relationship of IT and organizations through four decades

The introduction of IT in organizations started in the early **60’ies and 70’ies**, and from the very beginning, the potential of this technology to change jobs and organizations attracted the attention of several researchers. One of the first was the Ida Hoos, studying the impact of IT on insurance clerks (Hoos 1960). Later, Enid Mumford conducted a number of studies (e.g. Mumford & Banks 1967, Bjørn-Andersen et.al. 1979). These and other studies had the focus of trying to understand the nature and the extent to which the technology would create new work roles and as a consequence influence the job satisfaction of workers/clerks. Others studied the impact of IT on middle managers (e.g. Stewart 1971, Robey 1977, Bjørn-Andersen et.al 1986). And others again speculated on the impact of IT on organizational structures (e.g. Whisler 1970), hypothesizing that organizations would become hourglass shaped, because the need for middle managers would diminish substantially. But the key research question in this decade was the **impact of IT** on individuals and organizations.

In the 80’ies, the number of impact studies grew, but it is characteristic that the dominating questions in the 80’ies became one **organizational design**. Given the knowledge we had about the predominantly negative implications of IT, how could we go about improving the design of organizations and more deliberately improve on working conditions and design more effective organizations. Two major schools could be identified in this decade, the so-called socio-technical approach spearheaded by Mumford (e.g. in the Ethics method), and the political approach, where the largest efforts were the collaboration efforts with the trade unions (e.g. the NJMF project which started in 1973, see e.g. Bergo & Nygaard 1974), DUE (Kyng & Mathiassen 1980) and Daphne projects (Bjørn-Andersen, Clausen & Rasmussen 1977). For an overview see Bansler 1989. From a more management oriented perspective, the Japanese management principles of “flexible, agile and just-in-time concepts” were introduced in the beginning of the decade, followed by organizational models like “Shamrock organization” (Handy 1989), “Lattice”-organization (Gore 1985) and the very broad based movement towards “Business Excellence” as we see it e.g. in the EFQM awards (For a review of the European Excellence Model see <http://www.efqm.org>). Even though many of these developments came from the business side (business schools or management consultants) and not from IT, it is clear that to a large extent, the models/visions/scenarios were to a large extent based on the advances in IT enabling these new organizational forms.

In the 90’ies, it became clear that it was no longer efficient to look at each organization as an island and optimizing for the organization itself was much less effective than optimizing the total value chain. It is also clear that competition is very much between value chains e.g. the value chain of

Ford and GM. Since no chain is stronger than its weakest link, **Inter-organizational IT** systems or EDI became a key strategy for most organizations, and new organizational concepts like “Boundaryless” was introduced as we see in the citation from Jacque Welsh in his address to the shareholder meeting in 1990:

“Our dream for the 1990’ies is a boundary less company, a company where we have to knock down the walls that separate us from each other on the inside, and separate us from our key constituencies on the other side”

This vision was also behind the ideas of Lars Kolind, the successful CEO of the Oticon Company. Oticon went through a total metamorphosis into what Kolind named the “spaghetti organization” (For a review of the role of IT see e.g. Bjørn-Andersen & Turner (1993), and for a comprehensive analysis of this organizational model please see Morsing (1998). The spaghetti organization clearly builds on IT and telecommunications, which is providing the basis for this much more effective organizational model. Other popular management concepts involves ‘Postmodern’ and “Scandinavian model” emphasizing the more democratic leadership styles with a high level of delegation strongly supported by IT.

Later in the 90’ies, the concept of “virtual organizations” became very popular (e.g. Dubinskas 1993, Handy 1995, Malone & Laubacher 1998, Mandy 1995, Voss 1996), and many organizations as well as researchers followed the line of outsourcing of those company functions, which were not core. Since transaction costs involved in outsourcing were dropping substantially, it became much more advantageous to concentrate on core and source everything else from organizations offering “best-of-breed”.

Finally in this current decade of the **00’ies** we have seen the emergence of organizational models going beyond the traditional virtual organization with its outsourced functions. These are organizational models spearheading the values of innovation and **re-invention**. These development have been inspired by the dawn of the New Economy based on the World Wide Web and the Internet, and Evans & Wuster (1997, p 71) suggests

“Over the next decade, the new economics of information will precipitate changes in the structure of entire industries and the way companies compete”

In this perspective, the traditional value chain perspective is replaced with a value network perspective because of the huge diversity and complex nature of almost any product and service delivery. In the CISCO report (CISCO 2003) the concepts of New Virtual Organization and New Virtual Eco-system are introduced in response to these challenges, and the CEO of CISCO John Chambers is cited for saying

“The New Virtual Organization is the most fundamental and significant change in organizational structure, we have ever experienced”

Along a similar line, Häcki & Lighton (2003) are analyzing networked companies, finding a subgroup of very successful companies, which they called “Network Orchestrators”. These have gone very far in establishing gated networks of supplies and partners using standard functions as a lingua franca for exchanging information of all types. Ebay is a particular good example of such a company.

It is possible to depict these four research perspectives graphically in figure 1, where we have tried to show a number of the key organizational models and the approximate time of adoption. Obviously, there can be some discussion of the exact position of some of them. For instance should one could focus on the first introduction of the concept or the actual more widespread adoption. But the main thrust should be clear. IT does not have a deterministic impact, but IT has enabled a totally different ways of organizing, which are likely to be much more effective for a large group of companies in their pursuit of providing value for their customers.



Figure 1: IT enabled organizational changes

In this paper, we shall proceed to discuss newer developments in the direction of creating even more networked, even more knowledge intensive, and even more distributed organizations – the Ambient Organization. But before we go in detail with that concept, let's briefly discuss the technological development.

3. Technological development

For decades Moore's law based on the observation made in 1965, suggested that the number of transistors on an integrated circuit would double every 2 years. Others have argued that for hard disc storage and RAM storage we would see similar development. With current technologies there is an obvious higher limit, but recent research on quantum computing suggests (see e.g. www.iqc.ca) with as little as 2000 quantum bits it would be possible to develop a computer which will have a computing power to calculate in minutes what current super computers would require a million years to accomplish.

Similar technological developments take place in other fields relevant to the performance of future IT, which will have huge implications for user functionality criteria like

- Unlimited processing capacity – as we have seen above
- Unlimited storage – already now we can store the more than 1 million publications from the CBS library in digital form on less than 100 DVD's using the latest technology. Accordingly, for all practical purposes it would be possible to carry the full library in a conventional suitcase
- Unlimited telecommunication capacity including wireless communication– costs are now coming down so rapidly that there are few limitations on where one might work, and still almost be as if in the next room
- Totally ubiquitous technology – available anywhere and everywhere, always connected.

All these technologies will among other things be used for

- Vastly enhanced interactivity – technology will soon enable interactivity matching that of human to human interactivity in certain areas

- Vastly enhanced user friendliness – taking our individual needs and capabilities into account
- Vastly enhanced customization – providing those offers and support that we want or have demonstrated in our previous behavior that we use/would like to use

All of this suggests that organizations in general will find it more efficient to organize in a totally different way in order to service its customers. In fact we suggest that most organizations will develop at least part of its functions in the direction of becoming Ambient Organizations.

4. Ambient organization

The reader would be forgiven for not knowing the concept of Ambient Organization. In 2005 a quick search in Google revealed six hits all referring back to the same document by the author and a few colleagues. This document was an application for a large EU research project, which, however, for several reasons was not granted. In mid 2007 there are more entries on Google, but by and large, the concept hardly exists.

The inspiration for the concept of Ambient Organization came from the Information Society Technology research program (6th research framework program 2002 – 2006) of the EU. In this program the extensive miniaturization, proliferation and distribution of IT was named “Ambient intelligence”. Xerox first named this development as ubiquitous computing, while IBM decided to name it “Pervasive computing”. An issue of CACM was devoted to discuss these two concepts (Lyytinen & Yoo 2003).

In the 6th Research framework program of the EU it was suggested not to use any of these two US terms, but to use the concept of ambient intelligence for the phenomenon that the computational power is available everywhere. In the report ISTAG Scenarios for Ambient Intelligence 2010 (ISTAG 2001), the concept of Ambient Intelligence is discussed, and scenarios for how this might provide “greater user-friendliness, more efficient services support, user-empowerment, and support for human interactions” are developed. These scenarios describe a future “where people are surrounded by intelligent intuitive interfaces that are embedded in all kind of objects and an environment that is capable of recognizing and responding to the presence of different individuals in a seamless, unobtrusive and often invisible way”.

A more extensive definition of ambient intelligence is found on Wikipedia stating that Ambient Intelligence becomes a reality when we have:

- Unobtrusive hardware (miniaturization, nano-technology, smart devices, sensors etc.)
- A seamless mobile/fixed web-based communication infrastructure (interoperability, wired and wireless networks etc.)
- Dynamic and massively distributed device networks
- Natural feeling human interfaces (intelligent agents, multi-modal interfaces, models of context awareness etc.)
- Dependability and security (self-testing and self repairing software, privacy ensuring technology etc)

Even though we are not there yet, we suggest that when individuals are surrounded by ambient intelligence in the form of ambient technologies, this will also have significant implications for organizations. The ISTAG committee falls short of discussing any implications above the level of the individual (except indirectly in order for the environment to provide the solutions we see in the four interesting scenarios). Accordingly, in the following we shall attempt to develop scenarios for what we called “ambient organizations” capable of making the ISTAG scenarios come true.

We **define an ambient organization** as an organization which is

- enabled by the emerging Ambient technologies including advanced communication and collaboration schemes
- exploits virtual resources on a business-, function-, process-, and individual level and
- in this way redefines its organizational structures and business models through
- building strongly on non-contractual relationships with a wide range of individuals not on the payroll but contributing in a range of different ways (crowdsourcing)

in order to obtain sustainable value for meeting increasingly complex and ever more competitive environments.

5. Elements in value chain of an Ambient Organization (AO)

When a new organizational concept like that of ambient organization is proposed, this will have a number of similarities with other organizational models. As we shall see, the AO is an extension of the concepts/visions for virtual, networked organizations.

We shall propose to discuss the features of an AO on two levels, depending on whether the external resources are on an organizational level (often referred to but not limited to some kind of outsourcing scheme), or on an individual level (often referred to but not limited to crowdsourcing (Wired magazine June 2006)).

On the **organizational level** we may talk about the outsourcing of business functions e.g. call centers, logistics, and software development, using different models like contracts, alliances, and joint ventures/functions. These arrangements are then designed as virtual networks, alliances, network orchestrators etc as we have seen above. For a particular insightful example in the financial sector see e.g. Steve Elliot “Technology enabled innovation, industry transformation and the emergence of ambient organizations (2005). These arrangements may also vary a lot from extensive contract driven outsourcing of IT-functions to very loose, fluid and flexible arrangements of alliances like the Anheuser-Busch has done with the dating site “MingleNow” targeting clubbers who are on-line. Other arrangements are Japanese keiretsu based collaborations or the Network Orchestrator model of Ebay, which space does not allow us to go further into.

On the **individual level** the main idea is develop arrangements that will allow the AO to solicit something of value from non-employees like customers, treasure hunters, or inventors alike. It is characterized by the fact that individuals would not have any type of fixed contract, but there is a range of different types of typically very loose agreements. In many instances the contributor is not even rewarded by the organization (e.g. in the case of viral marketing) or if rewarded, the reward is based on an assessment of the value to the (Ambient) organization irrespectively of the effort it takes to deliver. In other words, it is a totally market/value driven reward system, where the value is assessed exclusively by the beneficiary (the ambient organization), but in some instances, the reward might be subject to negotiations.

As such, the phenomenon is not new. The so-called “Longitude problem” of determining the East-West position of a ship on the open sea with the same accuracy as the latitude is determined using the North star, was for long a huge problem hampering navigation of ships. After an unfortunate incident in 1707, where a large British fleet in thick fog ran aground, the British parliament passed an act in 1714 offering a prize of 10.000 £ to anybody who could come up with a method for determining the longitude within one degree.

In modern times Malone and Laubacher (1998) proposed the concept of the “e-Lance Economy” suggesting that the electronics networks would lead to a “new economy centered on the individual, where there would be devolution of the large, permanent corporations into flexible, temporal networks of people”. This has not taken place on a grand scale as yet, but we are seeing how large corporations to an increasing extent on the one hand are freeing themselves of large fixed costs

department/functions and on the other hand are exploiting and adding new capabilities through the use of different types of virtual resources.

We propose to discuss the phenomenon of crowdsourcing (sourcing from individuals outside the organization) using a number of examples already in existence today. We shall attempt some kind of overall logic by structuring the examples according to four of the elements in the value chain of a traditional organization.

5.1 Innovation

The dominating political mantra in this first decade of the new millennium seems to be innovation. Unless organizations in the Western world can innovate, the common belief is that they shall not be able to cope with the winds of globalization bringing cheaper and more competitive products/services to the end users. And as we saw above, the traditional hierarchical organization does not lend itself very easily to challenges of innovation. For instance, it is not very likely that an organization, which is streamlined and fine-tuned to deliver the most cost-efficient production/distribution, will be able to re-invent itself to become the most innovative (Hagel & Singer 1998). Accordingly, organizations might benefit from looking outside to get the ideas, solutions and inspiration that would help them innovate.

One example is that according to Nielsen (2007), no less than 15.000 individuals outside the Boeing company in some way or other contributed ideas to develop the Dream liner aircraft. These individuals are typically working in airlines, traditional suppliers, customers and even men in the street.

On a similar line, Procter & Gamble posts problems on a website called InnoCentive, offering large cash rewards to more than 90,000 "solvers" who make up a network of backyard scientists. (<http://en.wikipedia.org/wiki/Crowdsourcing>).

The Canadian gold mining group Goldcorp made 400 megabytes of geological survey data on its Red Lake, Ontario property available to the public over the internet. They offered a \$575,000 prize to anyone who could analyze the data and suggest places where gold could be found. The company claims that the contest produced 110 targets, over 80% of which proved productive; yielding 8 million ounces of gold, worth more than \$3 billion. (<http://en.wikipedia.org/wiki/Crowdsourcing>).

The obvious advantages of this ambient mode of innovation over the traditional R&D department is that problems can be explored at relative low costs, payment will only be by results, and the ambient organization can tap a much wider range of talent working from independent research institutions, amateurs or even individuals working for trading partners or even competitors.

5.2 Production

There are several examples of how production might be organized in alternative ways outside the traditional hierarchical organizations through the use of grassroots, and in that way contribute towards the organization becoming more ambient. A well-known example is Wikipedia delivering a service, which for most observers is superior to a conventional encyclopedia. Furthermore, think of World Wide Web or the Linux operating system, which was developed in much more democratic and largely voluntary organizations (See among others Malone & Laubacher 1998). We would even argue that it is highly unlikely that the WWW could even have been developed by one or a group of organizations, neither public nor private. The development process is characterized by a number of features that could only be mobilized in voluntary organizations. This does not mean that the full development process can be handled by the voluntary, open source communities. In most instances open source inventions like Linux could not have got its relative success in the market if it had not been for the huge intervention of large commercial organizations like IBM and Red Hat. It is the unique combination of the voluntary organization and the strong commercial companies which has brought the product to its current market position. But if we see it from the point of view of IBM, the development of Linux has been developed in an Ambient organization.

News articles are another interesting example of crowdsourcing. Many media companies are to an increasing extent relying on reporting from “real” experts, eyewitnesses or even expert bloggers. Financial Times (2006) reports on blogs that have more hits than traditional newspapers. Newspaper editors are also to an increasing extent being faced with a choice either to have professional journalists on a fixed payroll or to source his/her articles from free-lance journalists or even from bloggers writing for free. The former must be significantly better in order to keep his/her position.

Finally one might mention the Amazon Mechanical Turk launched by Amazon in 2005, which is an on-line marketplace, where companies wishing to crowdsource can post “Human Intelligence Task” in order for individuals to work on, execute and be paid for. This is marketplace for e-Lancers!

These examples show that the traditional hierarchical organizational model may not be the most efficient for many types of production, and that different ambient solutions on the one hand might be better (faster, cheaper and more innovative) and on the other hand would be far less risky, more flexible and better scalable.

5.3 Marketing

Over the last few years Internet advertising is coming of age and is proving to be huge. Today a larger amount is spent on Internet advertising than on cinema advertising, and Internet advertising is the only type of advertising, which is growing. The main reason for this is the potential for a laser sharp precision in hitting the potential buyer in the “moment of truth”, where he/she is searching for a particular product/service or even contemplating to buy it. The already now immense advertising profits of Google are a clear sign that this is very effective.

Even since the famous experiments of Cock & French during Second World War, we have known that the sender of a message is very important for the behavior of the recipient, in some cases even more important than the message itself. If I recommend a product/service to a friend/family, the chance that this will influence his/her behavior is typically much higher than the same message from the vendor.

This has been used extensively in the so-called viral Internet marketing, where the vendor is using marketing techniques through social networks using self-replicating processes, analogous to the spread of pathological viruses.

A good example is the small video clips forwarded on the Internet spreading like measles. A small video clip placed on YouTube and on other sites with a lot of traffic can do the trick. Recipients might find it so funny/interesting/disgusting that they forward it to their friends/family with a recommendation to view the video. An example of this is a 30 seconds video about the virus protection software called “Bullguard”, which has explicit (male) nudity. This less than 10.000 € video has now been seen more than 25 million times, and even though conversion rate from brand awareness to actually buying is not very high, the 25.000 downloads/day has been a tremendously effective campaign.

A slightly different but also extremely effective viral marketing campaign is the self-advertisement of hotmail where every recipient of a mail is invited to get his/her own free e-mail account on Hotmail.

A different type of marketing using crowdsourcing is the creation of communities around products (famous car brands) or services. The Lego Company has successfully created several communities like lego.com for children, Adult Friends of Lego for people investing seriously in Lego bricks, and a community for users of the advanced programmable toy called Mindstorms. The users/buyers of Mindstorms develop programs for the robots which they then upload on a Lego sponsored portal. In this way, the community is reinforcing the value of the product. Instead of a user being on his/her own, he/she can source good ideas, advanced programs and added features from the Mindstorms community.

But the creation of communities can also be supporting an Internet based marketplaces/portal. The portal “Trendsales.dk” has been very successful in creating a community of more than 25.000

women mainly between 15 and 30, who weekly go the web-site to buy and sell second hand quality clothes. But a substantial enhancement of this functionality has been the community building among this group, where a lot of information is offered to them creating a high feeling of loyalty and a wish to come back.

The key point is that in these examples, individuals who are in no way related/employed by the vendor are exploited in the process of increasing brand awareness, stimulating buying and enhancing the use of a particular product /service.

5.4 Quality assurance/after sales service

The fourth value chain element is after sales service, where the Internet and WWW today is used extensively for providing all types of relevant service information to owners/subscribers of everything from technical manuals in pdf to easy FAQ, communities, and chat etc. This is contributing to the quality assurance (report back errors), after sales service (report back on vulnerable spots), and idea for better use.

For instance, who of us think of ourselves as part of the Microsoft quality assurance team, when we respond to an error message “The desktop has encountered a problem. Unfortunately it will need to close down”. Interestingly, we are not in any way rewarded for the effort of sending the error message, but I guess that most of us do, and the reward, if any, comes in some very vague notion of self interest in the form of updates that will cause the desktop to encounter fewer problems. One could also argue that Microsoft is selling a product, which is still in Beta version. Microsoft has evidently decided that it is better/more cost-effective to have users perform the quality assurance rather than bothering to test the product properly before launching.

Along similar lines, organizations are creating communities that unite users in such a way that they can service themselves and more importantly develop extensions, new applications, and more advanced use, which will further enhance the value of the product/service for others.

6. Conclusion

Ever since the first introduction of IT into organizations, there have been speculations and investigations as to the way that IT might influence organizational structure/processes and entire industry structures. We have classified some of these attempts and proposed a taxonomy of the relationship between IT and the organization in the four decades 1970 - 2010. We have furthermore named the decades after the dominating perspective for the assessment of the relationship between IT and organizations over four decades.

Today we are seeing the emergence of a new type of organizations that we have decided to call Ambient Organizations, in order to stress the idea that the modern organization needs to be available everywhere. The Ambient Organization we suggest can usefully be thought of as a new organizational form, requiring new strategies and tactics.

In 1937 a young economist by name of Donald Coase wrote an article called “Why do we have organizations”, where he introduced the concept of transaction costs, emphasizing the key decision of whether to “make” rather than “buy”, i.e. the fundamental reason for establishing organizational hierarchies rather than buying everything in the market from whoever had “best business practice”.

We believe that the tremendous advances in modern IT for processing, communication and storing information in ways, which are much more user-friendly, directly customized, and dramatically enhancing interactivity, will pave the way for a totally new type of organization, which we have chosen to call Ambient Organizations. Please stay tuned for more research of this phenomenon.

References

- Airaghi, Angelo, Schuurmans, Martin: ISTAG Scenarios for Ambient Intelligence in 2010, European Commission Community Research 2001
- Bergo, O.T. & Nygaard, K.: Planlegging, styring og databehandling, Tiden Norsk Forlag, Oslo 1974
- Bjørn-Andersen, N, Hedberg, B., Mercer, D., Munford, E. & Solé, A.: The Impact of Systems Change in Organisations, Sijthoff & Noordhoff, Alphen aan den Rijn, The Netherlands, 1979
- Bjørn-Andersen, N. & Rasmussen, L.B.: "Sociological Implications of Computer Systems", in H. Smith & T. Green (eds.): Human Interaction with Computers. Academic Press, London 1980, page 97-123.
- Bjørn-Andersen, N. & Rasmussen, L.B.: "Det teknologiske imperativ". Conference Teknologi og Samfund. Rungsted, March 1979, 16 pages. English translation in proceedings from the Conference "Socioeconomic Problems and Potentialities of the Application of Micro-electronics at Work". Pergamon 1981.
- Bjørn-Andersen, N., Clausen, H. & Rasmussen, L.B.: "Demokratiske arbejdsformer - planlægning, humanisme og edb ("DAPHNE". Projekt applikation. Fællesrådet af Danske Tjenestemands- og Funktionærorganisationer. November 1977, 20 pages.
- Bjørn-Andersen, N., Eason, K., and Robey, D. *Managing Computer Impact: An International Study of Management and Organizations*. Norwood, NJ: Ablex Publishing Corp., 1986.
- Bjørn-Andersen & Turner J.: The Metamorphosis of Oticon, in Galliers. B. & Baets W. (eds.): Information Technology and Organizational Transformation, 1998
- De Witt, B., Meyer, R.: "Strategy, Process, Content, Context – An International Perspective", Thomson, 3rd Edition, 2004 p. 375-401
- Dubinskas, F. A.: Virtual organizations: Computer Conferencing and Organizational Design, Journal of Organizational Computing & Electronic Commerce, vol. 3, issue 4, 1993
- Elliot, S.: Technology enabled innovation, industry transformation and the emergence of ambient organizations, working paper, University of Sydney, 2005
- Gore, B.: One Pioneer, 1985, see <http://www.context.org/ICLIB/IC11/WholePer.htm>
- Handy, C: The Age of Unreason, Drake International, 1989
- Mandy, C.: Trust and the Virtual Organization, HBR, May-June 1995, product number 4363
- Malon , T. and Laubacher R.J.: The dawn of the E-lance Economy, HBR, September-October 1998 pp 145 – 152
- Häcki, R. & Lighton, J.: "The future of the networked company", McKinsey, Quarterly no. 3, 2001, p. 20-39
- Hagel J. & Singer. : Unbundling the organization, 1998
- Hoos, Ida: Automation in the office, Washington D.C. Public Affairs Press, 1961
- ISTAG: Scenarios for Ambient Intelligence, IST program, www.cordis.lu/ist/istag.htm, 2001
- Lyytinen, K. & Yoo, Y.: Issues and challenges in ubiquitous computing, CAM, vol 45, no 12, pp 63-65
- Malone, T. & Laubacher R.J.: The Dawn of the E-lance Economy, HBR, September-October, 1998, p 145 – 156
- Markus, Lynne. M. & Robey, D.: "Information Technology and Organizational Change: Causal Structure in Theory and Research" Management Science, Vol. 34, No. 5. May 1988, pp. 583-598
- Moore, James: "Predators & Prey: A new Ecology of Competition", Harvard Business Review, May/June 1993
- Moore, James: "The death of Competition: Leadership and Strategy in the Age of Business Ecosystems", Chapter 1, HarperCollins Publishers inc., 1996
- Morsing, M. (ed.): Managing the Unmanageable for a Decade, Oticon, 1998
- Mumford, E & Banks, O.: The Computer and the Clerk, Routledge and Kegan Paul, 1967
- Peters, Tom: "The WOW Project", Fast Company Magazine, May 1999
- Robey, D. "Computers and Management Structure: Some Empirical Findings Re-examined," *Human Relations*, 30 (11), November 1977, 963-976.
- Stephen S.: Envisioning the virtual training organization, McIntosh, Training & Development, 1995
- Stewart, Rosemary: How Computers Affect Management, Macmillan, London 1971
- Voss, Hans Werner: Virtual Organizations: The future is now, Strategy and Leadership, July August 1996
- Zmud, Robert W.: "Information Technologies for the 1990: An Organizational Impact Perspective", 1989
- Whisler, T.L: The Impact of Computers in Organizations, Praeger, 1970

A new look at an old problem: requirements determination and its challenges

Kalle Lyytinen

Iris S. Wolstein professor Case Western Reserve University, USA

Abstract

The age old adage is that good software development process starts with a good requirements determination process which states and models the requirements for an application in a coherent, concise and unambiguous way. The process determines the scope of the initiative and helps control the final outcomes. Most of the information in requirements is expected to be found from potential users using various elicitation and requirements discovery techniques like interviewing, modelling and so on. We conducted a field study about requirements determination processes in large and complex software development environments that covered automotive, aerospace, media, telecommunication, finance and health industries. The study involved interviews among 30 leading experts in large scale systems and their requirements. It shows a different and changing picture of software requirements. Requirements complexity has risen to an unprecedented level and needs a new mind-set, requirements do not cover applications but sets of capabilities or processes in an enterprise, requirements are anchored into existing legacy of capabilities and they need to address the tensions between stability and change, requirements are often driven by existing platforms and models,- not the other way round, systems have become so embedded in business processes that distinctions between functional and non-functional requirements are fictive, requirements framing is radically different between innovative and incremental changes, requirements are negotiated within the scope of project time, risk and scope, and requirements are not fixed but remain volatile. We also observe, that contrary to academics belief, the challenge is not in the modelling methods to find out and describe systems, but to scale up and relate system models to the other elements in the environment. We discuss challenges associated with these findings and suggest some future research avenues to address those challenges.

Putting the Theory Back into Grounded Theory: A Model for Theory Building in Information Systems

Cathy Urquhart

University of the Auckland, New Zealand

Abstract

Over the past decade there has been increasing interest in the use of grounded theory in information systems research. Grounded theory is a qualitative research method that seeks to develop theory that is grounded in data systematically gathered and analyzed. Grounded theory use in IS, however, has not leveraged the most important aspect of grounded theory – its ability to produce rich theory that can push forward the boundaries of our IS discipline. Most grounded theory studies in IS have used grounded theory solely as a coding method and are characterized by low theory scope and little depth of data analysis. The keynote discusses six essential aspects of theory building using grounded theory that will assist IS researchers to exploit the full potential of the method.

On studying socially constructed reality

Pertti Järvinen

University of Tampere, Finland

pj@cs.uta.fi

(The paper presented in the panel of IRIS30, Aug. 2007 at Tampere; please, ask the newest version of this paper from the author!)

Information technology (IT) systems are not transparent. For example, Olsen and Sætre (2007) found that customers, i.e. users and managers, did not know which kind inventory optimisation algorithm the new ERP (Enterprise Resource Planning) system used. Reading technology in general is difficult (Haythornthwaite 2006), but users necessarily do it. It is a question about the meanings that people then create about IT they attach to the world around them (Lee and Baskerville 2003). In this sense, subjective meaning is objective reality: The meanings that human subjects create, communicate, and hold are part and parcel of the world that a social scientist receives as the subject matter under investigation. Hence, I raise the question: *How to study* our new interesting but difficult topic, *socially constructed reality*?

We information systems (IS) researchers are not the first ones who are interested in socially constructed reality. There are many methodologists who studied this topic earlier. Therefore it is interesting to look at their arguments when they started to investigate this problem domain.

1. Glaser and Strauss (1967) and Grounded Theory (GT)

In his comment on misconceptions in applications of grounded theory Suddaby (2006) returned to its origin. “The methodology was developed by Glaser and Strauss (1967) as a reaction against the extreme positivism that had permeated most social research. They disputed the view that the social and natural sciences dealt with the same type of subject matter. Specifically, Glaser and Strauss challenged prevalent assumptions of ‘grand theory’, the notion that the purpose of social research is to uncover preexisting and universal explanations of social behavior. In making their challenge, Glaser and Strauss looked to the pragmatism and early symbolic interactionism, which rejected the notion that scientific truth reflects an independent external reality. Instead, they argued that scientific truth results from both the act of observation and the emerging consensus within a community of observers as they make sense of what they have observed. In this pragmatic approach to social science research, empirical ‘reality’ is seen as the ongoing interpretation of meaning produced by individuals engaged in a common project of observation.”

“Successful grounded theory research has a clear creative component. Glaser and Strauss were aware of this component and the tension it would create with those who find comfort in trusting an algorithm to produce results. Glaser (1978) used the term ‘theoretical sensitivity’ to describe the essential tension between the mechanical application of technique and the importance of interpretive insight. The tension ultimately proved to be a point of departure between the founders of grounded theory, with Glaser favoring creativity and openness to unanticipated interpretations of data while Strauss (and coauthor Juliet Corbin, 1990) became advocates of adherence to formal and prescriptive routines for analyzing data.”

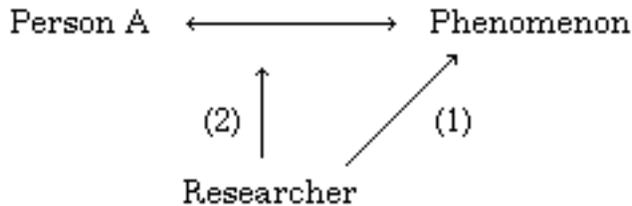
The formal and prescriptive routines refer to some techniques how to analyze gathered data, and Glaser did not like to emphasize those but more preferred a researcher’s interpretations. The differences between Glaser and Strauss reflect how far a researcher is from her research object. Strauss likes longer distance than Glaser. My interpretation is that Glaser likes a researcher to be native as ethnographers should be (Van Maanen 1979), because in socially constructed reality “members understand and continually renegotiate its meaning”.

2. Marton (1982) and Phenomenography

(This section is mainly taken from my book (Järvinen 2004, Section 4.3). Phenomenography is a qualitatively oriented research method for studying people's different conceptions of surrounding world. According to Marton (1982) phenomenography is intended to describe, analyze and understand conceptions: the aim is to describe the qualitative different ways in which various aspects of reality are seen and conceptualized and to search for logical relations between the categories of description arrived at.

A conception in phenomenographic terms is a very starting point from which a person views some aspect of reality. A conception has also been called the pre-reflective and reflective ground for action. Conceiving of the surrounding world is an activity through which a person creates meaning. It is done by organizing and differentiating of parts and wholes of different kinds of contents. When the phenomenographic ‘conception’ is discussed it is important to stress its relational character. This means that the reality is considered to exist through the way on which a person conceives of it (Uljens 1991).

The aim with the phenomenographic research is to show the *qualitative variation* in which a certain population understands something. Phenomenographers are thus not so interested in why people think as do. The idea of phenomenography is to describe the variation of how a certain population views something, not to explain the reasons for the variation. In phenomenographic literature a difference is made between a so-called first-order perspective and a second-order perspective. The first-order perspective (in Fig. arrow (1)) means that the researcher describes some aspect of reality directly, as s/he meets it (ethnographical, anthropological and observational studies). The second-order perspective (in Fig. arrow (2)), which is applied in phenomenography, means that the researcher describes some aspect of reality as it is conceived by a certain group of people. The second-order perspective is an indirect method in this way.



People do not have static conceptions but they change in the course of time. A difference has therefore made between a first and second-order relation (not perspective). This distinction is used when we talk about an individual (or a group) who has changed her conception. The relations can be illustrated as below:

T1: A ----- X
 T2: ↓
 T3: A :::::::X

Where T1, T2 and T3 are three situations, A is a person and X is a phenomenon person A has a conception of, '-----' is person A's conception of phenomenon X at time T1, '::::::::::' is person A's conception of phenomenon X at time T3. Finally, the vertical arrow represents the change from the first conception to the second conception. The first-order relation here is person A's conception of phenomenon X at time T1 and T3. The second-order relation is the change between conceptions.

When a person thinks, she always thinks of something in some way. When a person feels, she always feels something in some way. This traditional phenomenological standpoint regarding intentionality is also one point of departure in phenomenography (Uljens 1991). Mental acts are always directed towards something. This directedness of mental acts is intentionality. Mental acts mean here mental states which have been actualized in the mind. In phenomenography researchers try to describe a) what a mental act is directed to and b) in what way (how) it is directed thereto. This process of qualitative individuation of a mental act has been done when it's a) object and b) psychological mode (attitude) is shown. In ordinary language the verb reflects the mode and the grammatical object reflects the object of mental acts. To understand the whole mental act we have to know both the object and the mode of a person's mental acts. In this way we argue that what and how questions are interdependent; when we know how somebody's mental act is directed to its object we better understand the qualities of the object as the person perceives it.

The result of a phenomenographical study contains a set of all the different conceptions concerning the phenomenon under study. A researcher must not correct whether some conceptions are true or not.

Within phenomenography the research procedure usually consists of the following five steps:

1. The phenomenon (research object) or an aspect of it, is defined or limited
2. The chosen population is interviewed about the focus of study
3. The interviews are carefully transcribed, i.e. typed out
4. The interviews are analyzed
5. The analysis results in categories of description.

The first three steps are rather general, i.e. they exist in many other research approaches too. We therefore concentrate on two last steps. The phenomenographic analysis consists of four sub-steps.

1. De-contextualization

After having read the entire text with the aim of getting out its sense, you start to sort out meaningful units from the text according to the research question. The whole text is divided into meaningful units with the main focus on the subjects' utterances.

2. Transformation

The differentiated meaningful units are transformed into a more general and theoretical language. The transformation process includes interpretation of the differentiated units. The researcher tries to understand every meaningful unit in relation to its micro-context from the perspective of the initial research problem. The transformation is concentrated on the subjects' utterances, views and understanding of the phenomenon under study.

3. Characterization

All the meaningful units in one protocol belonging to the same sub-domain are compared with each other resulting in characterizations of the persons' conception concerning that sub-domain. Some meaningful units (utterances) appear to be more important than others.

4. Categorization

Characterizations on the individual level are analyzed in relation to each other. This analysis leads to one or more *categories of description*. It is often necessary to rerun to the micro-contexts of the different utterances and to interpret them from a new perspective.

The result of a phenomenographic analysis is presented in form of categories of description. A researcher determines the level of description, level of detail, level of abstraction. – To evaluate a researcher's position and influence on the categories found, those three steps (de-contextualization, transformation and characterization) are decisive. If the researcher does not know the phenomenon under study, i.e. s/he is not native, she can perform "wrong" de-contextualization or transformation or characterization). The more "native" the researcher is, the more truthful the categories are.

3. Orlikowski and Robey (1991) and the subjectivist and objectivist approaches

Orlikowski and Robey (1991) differentiated the subjectivist and objectivist approaches as follows: "In information systems research, the *subjectivist* approach to information technology is typified by those assuming 'social action' perspective on information technology. ... Prediction of consequences in this view is of limited value; more relevant is obtaining an understanding of the humanistic-interpretative process wherein those engaged with the technology enact various consequences. More mechanistic notions of cause and effect are deemed not useful in the prediction of technological consequences because social situations are not seen as governed by known, or knowable, causal relationships. ...

The *objectivist* approach to technology in information systems research is more common, but not necessarily more accurate. ... By presuming that technology is an object capable of having an impact on social systems, such research treats both technology and organization structures as objects. ... The objectivist approach overstates the importance of technology's

material characteristics and ignores the social interpretations and actions that may modify the impact of particular software systems or hardware configurations.”

The subjectivist and objectivist approaches as the crude categories differentiate the main approaches prevalent in social and natural sciences, respectively. We like the fact that Orlikowski and Robey (1991) warn to predict based on the results of the subjectivist approach.

4. Star and Ruhleder (1996) and when the infrastructure is?

Star and Ruhleder (1996) analyzed a large-scale custom software effort, the Worm Community System (WCS), a collaborative system designed for a geographically dispersed community of geneticists. They studied “the building of a geographically dispersed, sophisticated digital communication and publishing system for a community of scientists. The system-building effort, which was itself an attempt to enhance and create infrastructural tools for research, took place during a period of immense, even radical change in the larger sphere of electronic information systems (1991-1994). One purpose of the development effort was to transform local laboratory organization, and minimize inefficiencies of scale with respect to knowledge and results. The vision was a kind of supra-laboratory stretched over the entire scientific community. The needs for both standards and customizable components were equally strong. The system development process also became an effort to bring together communities of practice with very different approaches to computing infrastructure. Designers and users faced two sorts of challenges in developing the system: communicating despite very different practices, technologies and skills; and keeping up with changes occasioned by the growth of the Internet and tools like Gopher and Mosaic.”

“Despite of high user satisfaction with the system and interface, and extensive user needs assessment, feedback, and analysis, many users experienced difficulties in signing on and use. The study was conducted during a time of unprecedented growth in the Internet and its utilities (1991-1994), and many respondents turned on to the World Wide Web for their information exchange.” Using Bateson’s model of levels of learning, Star and Ruhleder analyzed the levels of infrastructural complexity involved in system access and designer-user communication. They analyzed the connection between systems development aimed at supporting specific forms of collaborative knowledge work, local organizational transformation, and large-scale infrastructural change.

“Experimentation over time results in the emergence of complex constellation of locally-tailored applications and repositories, combined with pockets of local knowledge and expertise. They begin to interweave themselves with elements of the formal infrastructure to create a unique and evolving hybrid. This evolution is facilitated by those elements of the formal structure which support the redefinition of local roles and the emergence of communities of practice around the intersection of specific technologies and types of problems. These observations suggest streams of research that continue to explore how infrastructures evolve over time, and how ‘formal’, planned structure melds with or gives way to ‘informal’, locally emergent structure.”

“In the end it seems that organizational change and the resolution into infrastructure are usually very slow processes. Local and large-scale rhythms of change are often mismatched, and

what it takes to really make anything like a national or global information space is at the very cutting edge of both social and information science.”

The case studied by Star and Ruhleder emphasizes a need for the longitudinal approach when researchers like to study social constructed realities.

5. Orlikowski (2000) and technology-in-practice vs. technological artifact

As both technologies and organizations undergo dramatic changes in form and function, organizational researchers are increasingly turning to concepts of innovation, emergence, and improvisation to help explain the new ways of organizing and using technology evident in practice. With similar intent, Orlikowski (2000) proposes an extension to the structurational perspective (Giddens 1984) on technology that develops a practice lens to examine how people, as they interact with a technology in their ongoing practices, enact structures which shape their emergent and situated use of that technology. Viewing the use of technology as a process of enactment enables a deeper understanding of the constitutive role of social practices in the ongoing use and change of technologies in the workplace.

“Using rich case studies of technological invention and development, social constructivist research examines how interpretations, social interests, and disciplinary conflicts shape the production of a technology through shaping its cultural meanings and the social interactions among relevant social groups. This research examines how the produced technology achieves ‘stabilization’ through processes of negotiation, persuasion, and debate aimed at achieving rhetorical closure and community consensus.”

“The adoption of social constructivist conception has also created some difficulties, primarily with respect of two propositions: that technologies become ‘stabilized’ after development; and they ‘embody’ structures which (re)present various social rules and political interests.

The first proposition – that technologies becomes ‘stabilized’ – neglects the empirical evidence that people can (and do) redefine and modify the meaning, properties, and applications after development. ... The second proposition – technologies ‘embody’ structures – is problematic from a structurational perspective, because it situates structures within technological artifacts. - Structure is here understood as the set of rules and resources instantiated in recurrent social practice.”

Orlikowski (2000) developed a new concept a *practice lens*, which posits human as constituting structures in their recurrent use of technology. The practice lens she is proposing “focuses on emergent technology structures enacted in practice rather than embodied structures fixed in technologies. This practice lens further recognizes that in both research and practice researchers often conflate two aspects of technology: the technology as *artifact* (the bundle of material and symbol properties packaged in some socially recognizable form, e.g. hardware, software, techniques); and the *use* of technology, or what people actually do with the technological artifact in their recurrent, situated practices.”

“Technology is, on the one hand, an identifiable, relative durable entity, a physically, economically, politically, and socially organized phenomenon in space-time. It has material and cultural properties that transcend the experience of individuals and particular settings. In this aspect, it is what we may call a *technological artifact*, which appears in our lives as a specific

machine, technique, appliance, device, or gadget. At the same time, use of the technology involves a repeatedly experienced, personally ordered and edited version of the technological artifact, being experienced differently by different individuals and differently by the same individuals depending on the time and circumstance. In this aspect it may be termed a technology-in-practice, to refer to the specific structure routinely enacted as we use the specific machine, technique, device, or gadget in recurrent ways in our everyday situated activities.”

“When users choose to use a technology, they are also choosing how to interact with that technology. Thus they may, deliberately or inadvertently, use it in ways not anticipated by the developers.”

“Use of technology is not a choice among a closed set of predefined possibilities, but a situated and recursive process of constitution, which – while it may often invoke intended activities or replicate familiar uses – may also and at any time ignore such conventional uses or invent new ones.”

“Use of technology is strongly influenced by users’ understandings of the properties and functionality of a technology, and these are strongly influenced by images, descriptions, rhetorics, ideologies, and demonstrations presented by intermediaries such as vendors, journalists, consultants, champions, trainers, managers, and ‘power users’.”

“Human interaction with technologies is typically recurrent, so that even as users constitute a technology-in-practice through their present use of a technology, their actions are at the same time shaped by the previous technologies-in-practice they have enacted in the past.”

“Technologies-in-practice can be and are changed as actors experience changes in awareness, knowledge, power, motivations, time, circumstances, and the technology. They are changed through the same process that all social structures are changed – through human action.”

Analytical considerations where Orlikowski (2000) utilized Giddens’ (1984) structuration theory, especially differentiation between two views on technology (technology-in-practice vs. technological artifact) support the subjectivist approach proposed by Orlikowski and Robey (1991) earlier, and give more many-sided picture of technology-in-practice and socially constructed reality in that context.

6. Baskerville & Lee (2003) and generalizing

In connection with different conceptions on generalizability Lee and Baskerville (2003) considered both positivism and interpretivism. Concerning the latter they describe: “A key feature of interpretivism that differentiates it from positivism, and hence also differentiates its approach to generalizability from positivism’s approach, is that interpretivism acknowledges the existence of a phenomenon that is not present in the subject matter studied by the natural sciences. People, who are integral to the subject matter that a social scientist observes, develop and use their own subjective understandings of themselves, their setting, and their history. Therefore, already present in the subject matter of the social sciences are the meanings that people create and that they attach to the world around them. In this sense, subjective meaning is objective reality: The meanings that human subjects create, communicate, and hold are part and parcel of the world that a social scientist receives as the subject matter under investigation. The presence of humanly created, and therefore sometimes contradictory, meanings and socially constructed realities in the subject matter of the social sciences has no counterpart in the subject

matter of the natural sciences: ‘The world of nature, as explored by the natural scientist, does not ‘mean’ anything to molecules, atoms, and electrons’ (Schutz 1962-66, p. 59).”

I can conclude the results of studies on socially constructed reality are not generalizable.

7. Topi et al. (2006) and some resources

Topi et al (2006) investigated “the use of informal notes for documenting and reusing ‘organizational knowing’. Following Cook and Brown (1999) Orlikowski (2002) differentiates between *organizational knowledge* and *organizational knowing*. The former term fits well with a taxonomic perspective that sees knowledge as something that can be treated as an object of action (store, categorize, organize, etc.; see e.g., Cook and Brown 1999). The latter focuses on the intrinsic relationship between knowledge and action and refers to the knowledgeability of individuals; that is, what they must know in order to get their work done on a daily basis.”

Informal, in this context, refers specifically to the lack of a formal organizational process leading to the creation of the notes. Topi et al. (2006) were interested in documents that were created by an individual or a small group without any managerial directive requiring or encouraging this activity. These informal notes are produced in response to emergent needs and thus are generated in action and in context. Topi et al. used communities of practice (CoP) (Wenger 1999) as a mechanism for understanding the context in which the notes are created and used. The notes that are analyzed are all intended for a relatively broad audience (either a workgroup or a department), have structured formats (i.e., word-processing or presentation software files), and are related to the business processes being captured by the ERP system, the technical details associated with system usage or both.”

Topi et al. (2006) write that “according to Wenger (1998, 2), there are three questions defining a community of practice: (1) What is it about – how do the members understand and continually renegotiate its meaning? (2) How does it function? What is the *mutual engagement* that forms the social entity? and (3) What capabilities has it produced? What are the resources the members have developed over time?”

When evaluated in terms of these questions, Topi et al. can identify the following characteristics of a community of practice in our ERP user groups: the users working on the same broad business process have a *shared* or *joint* enterprise that involves their use of the system for successfully completing those daily tasks that are related to system-specific processes relevant for this group. They are also engaged in communication with each other with the goal of reaching a better understanding about how to use the ERP system to support their business process (mutual engagement). Finally, and most importantly from the perspective of this inquiry, the members have developed knowledge resources (i.e., best practices regarding the use of the ERP system to achieve the business goals), some of which are represented in the informal notes.

Informal notes appear to be a type of artifact that enables employees to record and communicate the means for achieving goals related to their daily activities. While the creation of informal notes would first occur, the sharing and reuse of those notes would continue throughout the usage period. With regard to system usage, notes are likely to be revised and even created anew during the usage period as users discover new paths through the system and more efficient ways of accomplishing their goals. The creation/reuse/preserving of informal notes as artifacts for a community of practice is therefore a continual process whose lifecycle is cyclical rather than linear.

The following table summarizes the types of knowing in practice that are facilitated by the usage of informal notes repository.

Table: Knowing in practice supported by repository usage

-
- Knowing how to perform straightforward system tasks
 - Knowing how to diagnose and fix problems
 - Knowing what to do in error situation
 - Knowing who has specific competencies with the system and/or business processes
 - Knowing the meaning of system terms
 - knowing the relationships between system reports/transactions and business processes
-

The special merit of the study performed by Topi et al. is to concretely demonstrate part of socially constructed reality, informal notes, can emerge as resources, especially in knowledge and human resources. This raises a question about a boundary between an objective vs. socially constructed reality; is that boundary permanent or flexible in time. And the previous question still leads to another question: What is the unit of analysis of socially constructed reality?

8. Some conclusions

To summarize, we repeat that Glaser and Strauss (1967) originally based their *grounded theory* method on studying 'reality' as the ongoing interpretation of meaning produced by individuals engaged in a common project of observation. Marton's (1982) *phenomenography* is intended to describe, analyze and understand conceptions: the aim is to describe the qualitative different ways in which various aspects of reality are seen and conceptualized and to search for logical relations between the categories of description arrived at. Orlikowski and Robey (1991) differentiated the subjectivist and objectivist approaches and emphasized the *subjectivist* approach to information technology assuming 'social action' perspective on information technology. Orlikowski (2000) utilized Giddens' (1984) structuration theory, especially differentiation between two views on technology (technology-in-practice vs. technological artifact) supported that subjectivist approach and gave a rich picture of potential factors and their interrelationships behind the technology-in-practice. Star and Ruhleder (1996) implicitly emphasized a need for longitudinal approaches in analysis and description of changes in technical and organizational infrastructures. Although Topi et al. (2006) did not refer to Star and Ruhleder (1996) the results of the former group are similar as those found by the latter and in some sense even more concrete. In both studies the development of necessary and utile knowledge and human resources can be seen.

To relate potential opportunities to study socially constructed reality we take Järvinen's taxonomy of research methods. Referring to descriptions and definitions concerning socially constructed reality above, we tentatively propose we should use "theory-creating methods". If we shall find at the research site that consensus holds, we may find one tentative theory, otherwise two or more. Above Orlikowski (2000) analytically, Star and Ruhleder (1996), and Topi et al. (2006) empirically supported the latter.

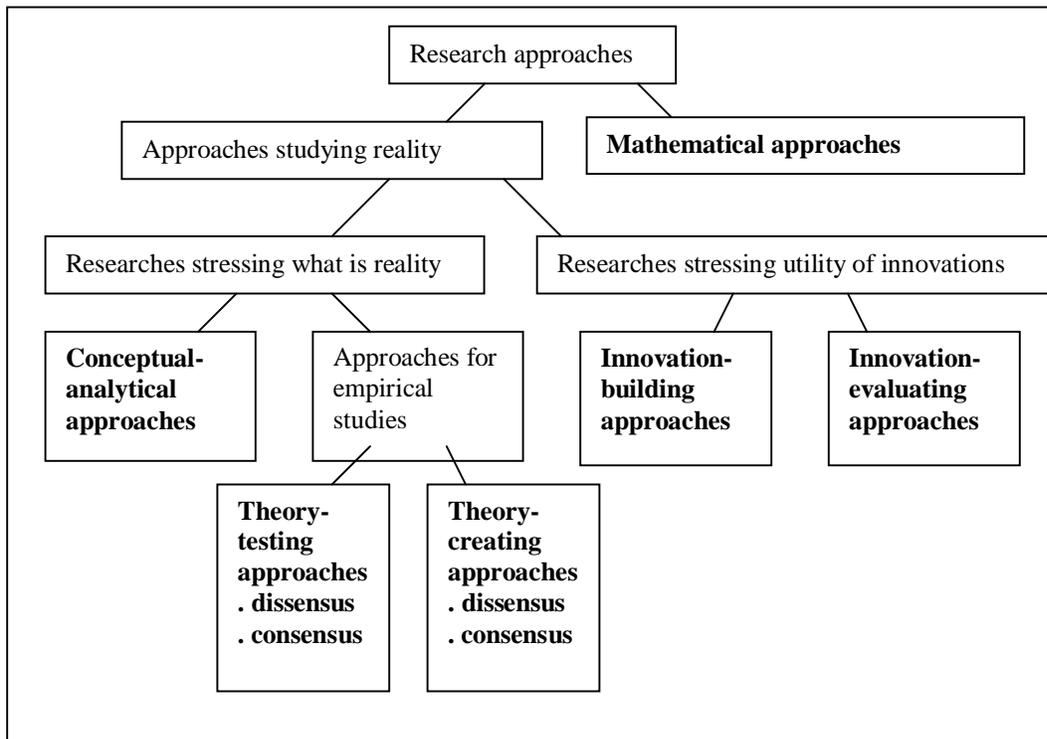


Figure Järvinen's taxonomy of research methods

Is it correct or incorrect to come to a result that there two different tentative theories? By definition, socially constructed reality means that the common meaning is produced in negotiations and re-negotiations among the *group* of individuals. Let's now consider research methods from the aspect of one group. I repeat, Glaser and Strauss (1967) originally based their *grounded theory* method on studying 'reality' as the ongoing interpretation of meaning produced by individuals engaged in a common project of observation. Phase "common project" might mean to that group, and the researcher could belong to that group, too. The researcher must be kept that in her/his mind when s/he is organizing her/his data gathering. (Remark: Also Strauss and Corbin (1990) in their version of grounded theory underline that the aim is to develop one tentative theory, called story.)

Concerning phenomenography, the originators of method stressed to find out all the different conceptions referring to the part of reality under study. Hence, more than one conception (or theory) was expected, and the way, how that conception was created, was negligible. If the researcher wants to use phenomenography in her/his study on socially constructed reality, s/he must select her/his group of informants in such a way that all those who were negotiating and re-negotiating on that conception belong to that group. – Hence, my conceptual analyses of grounded theory and phenomenography seem to underline the importance of data gathering and selection of informants.

In order to think about potential data gathering techniques, *group interview* seems to be promising (Chase and Alvarez 2000). The presence of the researcher or some outsider may then have some influence on data gathered, and hence data can be slightly distorted. Boland and

Tenkasi (1995) also described some applications of information technologies that could be employed for perspective making and perspective taking by communities of knowing. They call those applications as forums and present five forums: 1. Task narrative forums, 2. Knowledge representation forums, 3. Interpretive reading forums, 4. Theory building forums, and 5. Intelligent agent forums. *Task-narrative forums* serve as perspective making for those creating the narratives and also serve as a perspective-taking experience for those reading the narratives (cf. Tikkamäki 2006). Representational forums serve as a perspective-making experience for those constructing, revising, or commenting on an emerging representation within a community of knowing. They also serve as a perspective-taking experience for those who read them with a hermeneutic attitude of engaging the horizons of another thought world.

Our analysis and the articles referred above underlined the importance of the researcher's familiarity on the problem domain. The more 'native' she or he is, the more deep-going study she or he can perform.

We hope that our collection of the articles above, the direct citations from them and our tentative consideration will help and encourage other researchers to further study socially constructed realities and develop conceptual and concrete facilities to support research work on this important topic.

References

- Boland R.J. and R.V. Tenkasi (1995), Perspective making and perspective taking in communities of knowing, *Organization Science* 6, No 4, 350-372.
- Chase L. and J. Alvarez (2000), Internet research: The role of the focus group, *Library & Information Science* 22, No 4, 357-369.
- Cook S.D.N. and J.S. Brown (1999), Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing, *Organization Science* 10, No 4, 381-400.
- Giddens A. (1984), *The constitution of society*, Polity Press, Cambridge.
- Glaser B. (1978), *Theoretical sensitivity*, Sociological Press, Mill Valley Ca.
- Glaser B. and A. Strauss (1967), *The discovery of grounded theory: Strategies of qualitative research*, Wiedenfeld and Nicholson, London.
- Haythornthwaite C. (2006), Articulating divides in distributed knowledge practice, *Information, Communication & Society* 9, No 6, 761-780.
- Järvinen P. (2004), *On research methods*, Opinpajan kirja, Tampere, Finland.
- Lee A.S. and R.L. Baskerville (2003), Generalizing generalizability in information systems research, *Information Systems Research* 14, No 3, 221-243.
- Marton F. (1982), *Towards phenomenography of learning, I. Integrational experiential aspects*, University of Göteborg, Dept. of Education, 6.
- Olsen K.A. and P. Sætre (2007), IT for niche companies: Is and ERP system the solution?, *Information Systems Journal* 17, No 1, 317-342.
- Orlikowski W. (2000), Using technology and constituting structures: A practice lens for studying technology in organizations, *Organization Science* 11, No 4, 404-428.
- Orlikowski W.J. and D. Robey (1991), Information technology and the structuring of organizations, *Information Systems Research* 2, No 2, 143-169.
- Schutz A. (1962-66), *Concept and theory formation in the social sciences*, Collected papers, Nijhoff, The Hague.
- Star S.L. and K. Ruhleder (1996), Steps toward an ecology of infrastructure: Design and access for large information spaces, *Information Systems Research* 7, No 1, 111-134.
- Strauss A. and J. Corbin (1990), *Basics of qualitative research - Grounded theory procedures and techniques*, Sage Publications, Newbury Park Ca.

- Suddaby R. (2006), From the editors: What grounded theory is not, *Academy of Management Journal* 49, No 4, 633-642.
- Tikkamäki K. (2006), *Työn ja organisaation muutoksissa oppiminen – etnografinen löytöretki työssä oppimiseen* (Learning in changes of organization and work – an ethnographic journey to learning at work), Tampere University Press, Tampere, Finland.
- Topi H., W. Lucas and T. Babaian (2006), Using informal notes for sharing corporate technology know-how, *European Journal of Information Systems* 15, No 5, 486-499.
- Uljens M. (1991), Phenomenography – a qualitative approach in educational research, In Merenheimo and Syrjälä (Eds.), *Qualitative approaches to educational research*, No 39, University of Oulu, 80-107.
- Van Maanen J. (1979), The fact of fiction in organizational ethnography, *Administrative Science Quarterly* 24, 539-550.
- Wenger E. (1998), *Communities of practice: learning as a social system*
<http://www.co-I-L.com/coil/knowledge-garden/cop/lss.shtml>
- Wenger E. (1999), *Communities of practice: Learning, meaning, and identity*, Cambridge University Press, New York.

Cultural Aspects in Global Systems Development – An Analytical Tool

Sattar Al-Haydar, Fredrik Karlsson

Methodology Exploration Lab, Dept. of Informatics (ESI), Örebro University,
SE-701 82 Örebro, Sweden

{sattar.al-haydar|fredrik.karlsson}@esi.oru.se

Abstract. Global systems development has increased in interest during recent years, motivated by the possibility to find high skilled resources at low cost in different parts of the world. However, as well as this trend has opportunities it also introduces new complexity. One part in this complexity is cultural aspects. Although there have been research studying systems developers' values across cultures we lack in-depth investigations on how their values affect their use of systems development methods or parts thereof. In this paper we have elaborated on a model for analyzing cross-cultural settings and systems development methods. The model is anchored in two conceptual frameworks, a framework of systems development method and a framework of culture, using the concept of rationality resonance. The tool focuses on the potential to achieve rationality resonance between different cultures and systems development methods.

Keywords. Culture, Systems development method, Method rationale, Rationality resonance.

Introduction

Development of information systems in another country, such as offshore or global systems development, are phenomena that have received increased interest during recent years (Ferranti, 2004, Webb, 2004, Walsham, 2002). It is motivated by the possibility to find high skilled systems developers at low cost (Sakthivel, 2004) in countries such as China and India. This phenomenon has been made

possible through the use of advanced information and communication technologies (ICT). Furthermore, this technology development has created possibilities to shorten the development cycle. For example, Pries-Heje et al. (2005) use the terms “agile development” and “Internet-speed development” to capture this trend.

As Kankanhalli et al. (2003) state, global systems development is not without risk. Systems development is often characterized by complexity and uncertainty, which is often met through the use standardization of tasks. Often it is done through the use of systems development methods. Prior research have shown that cultural context affect systems development (e.g. Kumar and Bjorn-Andersen, 1990, Couger et al., 1990), hence systems development is not a homogenous concept over the world. Although there have been research studying systems developers’ values across cultures we lack investigations on how their values affect their use of systems development methods. Having a better understanding on cultural aspects in relation to the use of systems development methods may help to improve global systems development.

In order to create better understanding of cultural aspects and systems development methods an analytical framework is needed. With such a tool it is possible to provide future maps on how different cultures relate to different types of or parts of systems development methods; maps that can be used when choosing the systems development methods and set up a cross-cultural project team. Subsequently, the objective of this paper is to present a conceptual framework for analyzing the impact of cultural aspects on systems development methods.

The remainder of the paper is organized in sixth sections. In the following section we discuss the research method. The third section is devoted to related research. In the fourth section we take a closer look at the concept of systems development method and in the fifth section we introduce culture as an aspect affecting the use of systems development methods. Furthermore, in that section we elaborate the analytical framework. The sixth section contains an application of the analytical framework during two case studies, one study combining Egyptian and Swedish cultures and one with the combination of Swedish and Finnish cultures. Finally, in the seventh, section of the paper we end with a short conclusion on further research.

Research method

The heart of this paper is the developed conceptual framework. The research presented in this paper has characteristics of design science research, with a focus on March’s and Smith’s (1995) model layer. Hence, we are searching for a set of constructs and their relationships for analysis of the impact of cultural aspects on systems development methods. As such the purpose is not to judge the framework

as “true”, rather it is a search of utility (Hevner et al., 2004). The framework development has been carried out during two case studies (Yin, 1994). The conceptual development has been an iterative process between existing theoretical frameworks, the empirical cases and our new model.

Two theoretical frameworks have been used as input for this work:

- (1) The systems development method framework of Karlsson & Wistrand (2006) and Karlsson (2005).
- (2) The culture framework of DeLong and Fahey (DeLong and Fahey, 2000).

Both these frameworks emphasize the importance of acknowledging the concept of value, which is essential for our work. The importance of values during systems development has been discussed by, for example, Ågerfalk and Fitzgerald (2006). Existing conceptual models have been converted into models sharing the same modelling primitives and notation in order to ease the analysis. We have, for example, used UML (Unified Modelling Language) class diagrams during this process.

Braa and Vidgen (1999) distinguish between hard and soft cases, where the latter focus more on gaining understanding instead of prediction. The chosen research strategy is in line with the purpose of understanding cultural aspects on systems development methods. During selected case studies we have used primary observations for data collection. These observations have been done during project and work meetings. This choice has been based on the need to capture how people relate differently to social constructs based on culture. The use of project and work meetings, which are everyday situations, provide us with data about how people relate to concepts in natural settings. From our point of view it has been important not to study constructed situations, which Braa and Vidgen (1999) term field experiment and quasi experiment.

Systems development methods are, as described in the Section The concept of systems development method, social constructs. These constructs are often highly complex. As this is a pilot study we chose a smaller unit of analysis and we have chosen the the concept of time. As Levine (1997) states, time is a social concept, which is interpreted differently by people. Furthermore, this concept is a component in systems development methods, for example, it is a key construct in such concepts as work schedules, calendars, deadlines and checkpoints.

Two obvious examples of how time is used in systems development methods are timeboxes and sprints (Schwaber and Beedle, 2001) in agile methods. They are often implemented as iterations (Beck, 1999), typically a couple of weeks. Subsequently, together with each iteration we have a deadline when the planned increment has to be delivered. With different views on the concept of time, we will have different views on meeting deadlines and working with timeboxes. Another example, is how project progress is reported in, for example, SCRUM. In

SCRUM the number of hours for the remaining work is presented (Schwaber and Beedle, 2001). If the presented hours are decreasing it means that the project is making progress. Hence, it is anchored in the assumption that we have a shared view of the hour concept. In addition, the concept of time as well as related concepts are implemented into information systems used during systems development processes. Examples of such artefacts are Microsoft Outlook, Microsoft Project and Open Workbench. Hence, the implementations in these tools represents a view on the concept of time.

When it comes to the choice of research sites it has been based on two premises: 1) there had to be cross-cultural settings in the selected cases 2) they had to provide access to the business context. The first condition follows naturally from the aim of the study. The second aspect is highly important in order to make observation in the daily context possible.

The choice of research sites fell on meetings in Egypt and Sweden. Each meeting was viewed as a small timebox with a defined start, end and purpose. Hence, it resembles the use of timeboxes in systems development methods. In addition this choice provided us with the following settings: the first case is from a collaboration project between an Egyptian and a Swedish organization and the second case is from collaboration between a Swedish and a Finnish organization. Sweden and Finland are countries with long tradition of systems development, while Egypt is a country with offshore systems development potential. Furthermore, this choice provided us with one case with potentially larger cultural differences and one case with potentially smaller differences. The studied meetings were part of different kinds of development contexts. Since it is not possible to cover complete case studies in form of meetings in this paper we have selected parts. In order to distinguish a specific meeting and the presented part thereof, we term the latter 'episode.'

The observations have been structured with a focus on; 1) how managers acted with regard to deadlines and time constraints 2) how they explained their actions. 3) The reaction that this action causes among the people at this meeting. The first part captures what actually happened during a meeting. The second part provided us with data about the manager's public rationale (Stolterman and Russo, 1997) for this action. However, it does not provide us with the person's private rationale, that is reasons that the person does not want to or cannot express. Through the third action we capture indications whether this is an accepted part of this group.

Related research

Different studies on cultural aspects, system developers' values and systems development can be found in the literature (Dagwell and Weber, 1983, Kumar and Bjorn-Andersen, 1990, Huang and Palvia, 2001). Early studies have had a

focus on, for example, value differences between Anglo-American and Scandinavian system development traditions (Dagwell and Weber, 1983). Furthermore, much attention has been paid to issues on user job-satisfaction.

A number of studies can be found that focus on the cultural differences for specific types of information systems (Huang and Palvia, 2001, Arnott et al., 2007) and cultural impact of ICT diffusion, adoption and use. These studies can be divided into two groups (Hofstede, 1980, Hofstede et al., 1990, Trompenaars, 1996, Walsham, 2001, Walsham, 2002):

- the impact of national culture on ICT
- the impact of organizational culture on ICT

These studies add to an understanding of why different information systems succeed or fail. But, their concerns are about the final product and not as much about the systems development process.

As noted by Walsham (2001, 2002) project team members need a deeper understanding of how culture affects systems development processes. He argues that global systems development will fail unless we are able to bridge the gap between different cultures. For example, differences are found between Non-Western and Western cultures with regard to individual control and self-sufficiency (Walsham and Sahay, 1999).

Since our focus in this research is on systems development process support and cultural aspects in global systems development, an in-depth understanding of the cultural aspects is important. Furthermore, it is a deeper understanding of the 'new' cultures in global development that should receive attention, hence including potential value differences that can be different from comparisons of, for example, Anglo-American and Scandinavian cultures.

The concept of systems development method

System development methods can be viewed as the content of a system development process. They are the containers for how to work and what to produce, with an aim to reduce project risks. The concept of systems development method is a complex one and has a long history in the field of information systems development. Subsequently, many scholars have provided their views and definitions of the concept (e.g. Rumbaugh, 1995, Checkland, 1981, Brinkkemper, 1996, Russo and Stolterman, 2000, Goldkuhl et al., 1998).

Even though it is possible to find different definitions there seems to be a common understanding of what constitutes the core of systems development methods. The concept has three interrelated parts: prescribed actions, concept and notation. The prescribed actions tell project members what actions to take during a specific part of a systems development project. These prescribed actions are

found together with sequence restrictions. The process tells a developer what actions to take in a specific phase, such as draw class diagrams during requirements engineering. The results produced during these activities are documented using specific notation, such as class notation in Unified Modeling Language (Bolloju and Leung Felix, 2006). Each part of a notation is used to represent a more precise languages used by the project members. This language is constructed based on the specific concepts which are used to describe the problem domain and the method itself.

In addition to these three core concepts Karlsson (2005) chooses to extend the concept of method with artefact and actor role. Methods make use of and produce artefacts; they are used as input for transformation and/or are results from transformation. For example, uses cases are usually used as input when writing test cases. Finally, the fifth element of a method is actor role. Actor roles are played either as drivers of the prescribed actions in the method or as participants. For example, the Business-Process Analyst is the driver of a business use case session in Rational Unified Process, while workers are participants.

Based on these five parts Karlsson (2005) chose to define method as: ‘a structured set of prescribed actions with corresponding artefacts and roles, based on a particular perspective on the problem domain.’ This definition of the method concept contains an important aspect with respect to our problem area. Karlsson (2005) states that each method is based on a particular perspective on the problem domain. According to Brinkkemper (1996), each method is grounded on a way of thinking and Jayaratna (1994) as well as Iivari et al. (2001) use the term ‘philosophy’. Perspectives such as function oriented (Yourdon, 1989) and object oriented (e.g. Blaha and Premerlani, 1998, Coleman et al., 1994) shape methods. Subsequently we view methods as normative; namely the way of thinking governs the operationalized directions and rules. A perspective means the way the world is perceived by the method creator and later the method user. Every method or model is based on a perspective (Goldkuhl, 1991, Nilsson, 1995). For example, using a set of concepts means that project members bring certain things to attention, based on these values. Moreover it means that other things are placed in the background. With regard to our cases studies we can conclude that different perspectives affect how the concept of time is prescribed in systems development methods as well as how it is perceived by developers. As Levine (1997) points out at least three views can be found: nature-time, event-time, and clock-time. The most common use of the time concept in systems development methods is clock-time.

From another angle we can conclude that prescribe actions are performed for reasons to fulfill goals, and a perspective becomes the argumentative dimension of a method (Ågerfalk and Åhlgren, 1999, Jayaratna, 1994) often described as method rationale (Ågerfalk and Fitzgerald, 2006, Karlsson and Wistrand, 2006). These goals can be based on the most basic concept in the perspective, namely

values. One example is the role the user plays during the systems development process. The role has changed over the decades from passive to a more active and participating one (e.g. Dahlbom and Mathiassen, 1993).

Often, when we use methods or models we do not reflect on the perspective that is induced. It is certainly possible to find several causes but the perspective might not be expressed explicitly in the method description as such. In many cases, the perspective is implied, which is usually the case with tools. Irrespective of the awareness of the applied perspective, it justifies the way in which the method is constructed.

However, this view on method is simplified. It is possible to identify discrepancy between a documented method and how it is used. Fitzgerald et al. (2002) use the concept of method-in-action and Goldkuhl (2002, 1999) acknowledges that method exists in different realms: the subjective realm, the inter-subjective realm, the linguistic realm, the action realm, and the consequence realm. Subsequently, different views on the 'same' systems development method exist in parallel as well as different acceptance of this method.

Cultural aspects

The concept of culture is a difficult one to define since it is intangible and hard to observe at different levels in organizations and societies. The literature on culture provides a set of different culture definitions. Traditionally, culture has been defined as common values and attitudes (Morgan, 1986) for people who live in close proximity to one another. Culture has also been defined as a set of attitudes of people to the production process and symbols (Burchell et al., 1980) and as ideology, language, rituals, myths and ceremony (Pettigrew, 1979).

DeLong and Fahey (2000) use three basic elements in their definition of culture: values, norms and practices. These constituents affect people's behavior, for example systems development behavior. DeLong and Fahey (2000) describe values as 'embedded, tacit preferences' that indirectly affect behavior through norms. Hence, it corresponds to the concept of value in method perspective. For example, assume a systems development organization holding the value that user participation is important in systems development. It addresses the co-operation forms in the systems development projects that this organization undertakes. When an organization believes in this value the co-operation form has to include a dialogue between different groups of end users as well as a dialogue between end users and systems developers. Hence, values will inspire developers to include end users into the development process, selecting part of systems development methods that support this end.

In the model of DeLong and Fahey (2000) norms are derived from values and are viewed as more susceptible for change over time. They constitute standards, models, and patterns regarded as typical. Continuing on the example above norms

can exist for user involvement. If developers believe that inviting users to requirements workshops facilitate systems development, then the norm supports user involvement.

Practices are relatively superficial elements of a culture, expressed in collective habits such in the way in which meetings are conducted, language and special professional vocabulary, status symbols, clothing style, and communication style. Subsequently, practices resemble the concept of method. For example, the language used during a requirements workshop affects user involvement. If the developers use too much of their professional vocabulary it could hamper the dialogue and the possibilities to elicit the requirements.

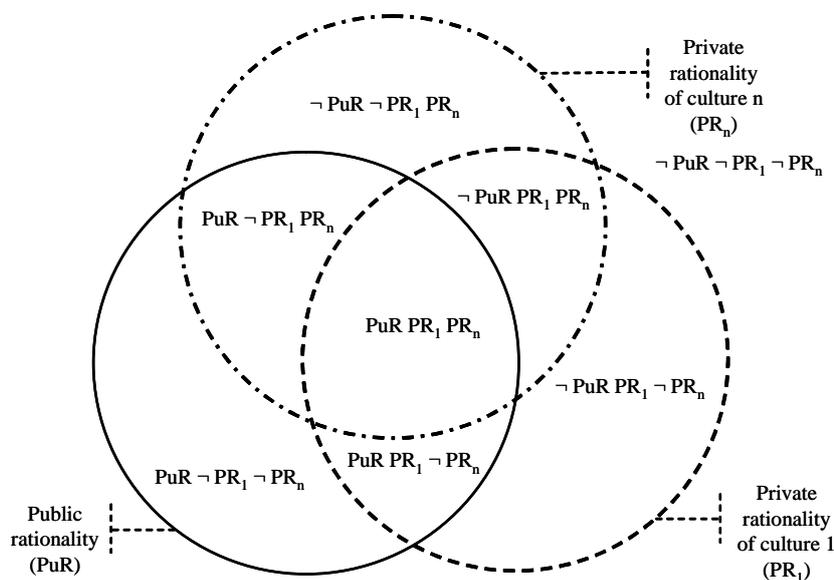


Figure 1. Model for analyzing rationality resonance in cross cultural systems development. The capital letters refer to the corresponding category and the symbol \neg represent not, that is PuR = public rationality, \neg = no public rationality.

Conceptually we find relationships between DeLong’s and Fahey’s (2000) view on culture and Karlsson’s (2005) view on systems development methods. The most fundamental part in both models is the concept of value. It provides an opportunity to discuss the possibilities to achieve rationality resonance (Stolterman and Russo, 1997) in a global systems development process and how it affects norms and practices. When considering rationality resonance, it is possible to distinguish between public and private rationality. Public rationality concerns the objective understanding of actions and results prescribed by a systems development method. This aspect of method rationale thus relates to the way a systems development method is described and communicated in, for example, method handbooks. Private rationality, on the other hand, is personal and not possible to externalize in every aspect. It is expressed ‘in the skills and in the professional ethical and aesthetic judgments’ (Stolterman and Russo, 1997) of

a person and relates to the way a systems development method is enacted in actual development practice, as method-in-action.

The Venn-like diagram in Figure 1 depicts the concept of rationality resonance in a cross-cultural context. The diagram contains three spheres based on the discussion above: Public rationality (PuR), Private rationality of a person representing culture 1 (PR_1) and Private rationality of a person representing culture n (PR_n). The symbol \neg represent a boolean not. Together with the abbreviations it results in, for example, PuR = public rationality, \neg = no public rationality. The sphere of culture n is dotted. It indicated that the model can contain a number of cultures between 1 and n. For each culture added we need to add another sphere and the complexity of the model, as well as the reality, increases.

Table 1. Rationality resonance situations

Situation	Description
\neg PuR \neg PR_1 PR_n	Rationality resonance does not exist. The values of culture n is neither matched in the method or the first culture.
PuR \neg PR_1 PR_n	Partial rationality resonance exists, in this case between the method and culture n.
PuR PR_1 PR_n	Rationality resonance exists between both cultures and the method.
\neg PuR PR_1 PR_n	Partial rationality resonance exists, in this case between the two cultures but it is lacking method support.
PuR \neg PR_1 \neg PR_n	Rationality resonance does not exist. The values of the method is neither matched in the first culture or culture n.
PuR PR_1 \neg PR_n	Partial rationality resonance exists, in this case between the method and the first culture.
\neg PuR PR_1 \neg PR_n	Rationality resonance does not exist. The values of the first culture is neither matched in the method or in culture n.

The spheres in Figure 1 partly overlap each other. Each overlap shows rationality resonance between the spheres. Altogether, if we demarcate the model to handle two cultures, we end up with seven situations. These situations are presented in Table 1, which has two columns. The leftmost column contains the situation with reference to the content in Figure 1, while the rightmost column gives a short description. For example, PuR \neg PR_1 PR_n on the second row means that rationality resonance exists partly. Rationality resonance is found between the systems development method and culture n. However, rationality resonance is not found between the method and the first culture, nor is it found between the first culture and culture n. Another example is found on the third row. There we find rationality resonance between both cultures and the systems development

method in use. Subsequently, in such a situation the method is a support for people from both cultures.

The sense of time

The time concept is complex and intangible. We all accept its existence in our lives but it is difficult to define. Levine (1997) states that time is a psychological and social construct stimulating individual behavior. According to him time can be divided into at least three key concepts:

- (1) Nature time: is based on the celestial bodies and the seasons.
- (2) Event time: is based on how long it takes to complete a specific task or job.
- (3) Clock time: is based on standardized periods.

The Egyptian-Swedish episode

The Egyptian-Swedish episode is from a meeting in Cairo, the capital of Egypt. This meeting was part of a collaboration project between two organizations. It was held with a manager of an information systems development company and the first author of this paper and the meeting had been scheduled in advance. The manager had responsibility for the collaboration efforts on the Egyptian side, while the author was coordinating the Swedish activities. They met face-to-face for the first time during this meeting but had spoken over the telephone and used e-mail during earlier contacts. The meeting was held at the manager's office.

The meeting started fifty-four minutes late, since the manager was not in his office at the appointed time. During the opening of this meeting thirty minutes were spent on initial welcome and trust building before we started on the first point in our agenda. After a few minutes the reminder of the manager's Outlook calendar displayed on his computer. He closed it and commenting 'I have a meeting in five minutes.' In a Swedish (person's) mind it meant that the meeting had to be finished within five minutes. When bringing this to his attention, that we could continue the meeting at another time, the manager took the problem lightly. He commented these worries: 'Do not get upset at silly things like this, for your sake I will cancel the meeting.' The computerized calendar continued to alert. Each time it did the manager closed the pop-up message with a smile. The meeting continued for another half hour, before it was closed.

The Swedish-Finnish episode

The Swedish-Finnish episode is from a meeting in Stockholm, the capital of Sweden. This project meeting was part of a development project, in this case between two organizations as well. Three people attended this meeting, two

persons from a Swedish organization and one person from a Finnish organization. The Swedish team consisted of one manager and a developer, where the second author of this paper acted as developer. Together these two organizations were building a new information system. As in the Egyptian-Swedish episode it was the first project meeting, and this meeting had been scheduled in advance. The initial contacts had been taken by e-mail to set up this meeting in a conference room. During this meeting the Swedish manager acted as chairman.

All participants had arrived well on time which meant that the meeting could start on time as well. The meeting time was scheduled to four hours. As with the Egyptian meeting it started out with an introduction section to build trust before starting on the official agenda. The trust building phase took about five minutes. The Finnish participant stated that we had to keep time because he had another appointment after this meeting. Then the chairman gave a short introduction of the purpose with this meeting and presented the agenda. During this meeting initial system requirements had to be drafted and a preliminary project plan.

The chairman used the agenda as guidance for the meeting, carefully allocating time for each issue. For this purpose he kept a close eye on his watch. However, all participants were keen to move forward in the agenda, in order to keep the time. At the end of the meeting the Finnish member looked at his watch frequently to check how much time he had left. Before closing the meeting the chairman made a summary. He checked that each issue had been covered and decisions were made on how to proceed with the tasks after this meeting. The meeting was closed on time.

Analysis

The purpose of the examples above is to review the concept of time in two different cross-culture settings. To this end, we will analyze values, norms and practices in the examples presented above. However, at this stage we want to point out that both managers have responsibility for producing high quality information systems and that none of these styles are 'better' than the other. The purpose of this analysis is to illustrate how cultural aspects emphasize different parts of a systems development method.

Fundamentally this analysis is anchored in different values about time and building social relationships. In some societies such as the Swedish and the Finnish, activities are scheduled to be done one at a time, sequentially. It is common to have a mind that is sensitive to a time norm that can be categorized under "Clock time" in our description above. For example, from a Swedish point of view, there is no discussion once the calendar alert comes up, the manager will interrupt the meeting. The Swedish managers' time are viewed as tight and inflexible.

In other societies, for example Egypt, time is not a commodity which can be scheduled. Everything takes its own time by nature. Therefore things can happen

simultaneously; “Event time”. In our case study, if the manager cannot participate in a meeting, he calls and gives some excuse as to why he can not come. Subsequently, the Egyptian experience tells us that much less is concerned with clock-time than the Swedish experience. This is in line with the Pati’s (1973) conclusion about Arab culture.

Table 2. Analyzed aspects of time

Aspects of time	Egypt-Swedish	Swedish-Finnish
1. Time needed to set up meeting	Long	Short
2. Starting time	Delayed	On time
3. Ending time	Delayed	On time
4. Time for trust building	Significant	Insignificant
5. Time for social concerns	Significant	Insignificant
6. Time for business concerns	Insignificant	Significant

In the view of our examples concerns with time manifests itself in different behavioral patterns as illustrated in Table 2. The table is structured into three columns. The leftmost column contains analyzed aspects of time. The second and third columns are used to present the Egyptian-Swedish and the Swedish-Finnish cases respectively. The analyzed aspects of time in Table 2 are related to defining the timebox (1), handling of the start and the end of the timebox (2, 3) and focus on the agreed purpose of the timebox (4-6). These examples show that time is conceived and prioritized differently. This is not surprising since the concept of punctuality does not exist in traditional Arab culture. Earlier research has shown that the introduction of exact time schedules, demanded by modernization, has encountered great difficulties (Pati, 1973).

Furthermore, it is possible to classify both meetings using the rationality resonance model. During each of these meeting the managers chose how the time concept was applied. Subsequently, with respect to method it was part of the official way of working and represents the public rationality of time during this meeting.

The Egyptian-Swedish episode is classified as $\text{PuR}_{\text{Time}} \neg \text{PR}_{\text{Swedish}} \text{PR}_{\text{Egyptian}}$ that is partial rationality resonance existed on how the concept of time was used during this meeting. Rationality resonance was found between the Egyptian and the time concept, but not between the Swedish and the time concept. Furthermore, there is no rationality resonance between the two spheres of private rationality. Subsequently, there was no shared understanding on how to treat the timebox.

The Swedish-Finnish episode is classified as $\text{PuR}_{\text{Time}} \text{PR}_{\text{Swedish}} \text{PR}_{\text{Finnish}}$. During this meeting rationality resonance existed on how the concept of time was used and how to treat the timebox. Rationality resonance was found both between all three spheres.

Conclusion and further research

As pointed out in the Introduction of this paper global systems development has increased in interest. It is motivated by the possibility to find highly skilled development resources at low cost in different parts of the world. However, as well as this trend has opportunities it also introduces new complexity. One part in this complexity is cultural aspects containing values, norms and practices. The increased complexity comes from the need to create rationality resonance between the systems development methods and the developers during systems development processes. In order to do that, an in-depth understanding of cultural factors is the key to determine the potential of achieving rationality resonance.

In this paper we have elaborated on a model for analyzing cross-cultural settings and systems development methods. The model is anchored in two conceptual frameworks, a framework of systems development method and a framework of culture, using the concept of rationality resonance. The model focuses on the potential to achieve rationality resonance between different cultures and systems development methods. A small pilot study has been conducted to test the model, illustrating difference in rationality resonance on the concept of time, a concept that is an essential component in systems development methods.

Further research is needed to elaborate and validate the model. Based on this model it is possible to create maps on how different cultures relate to different types or parts of systems development method with respect to rationality resonance. Such results can help systems developing managers when approaching global systems development.

References

- Arnott, D., Jirachiefpattana, W. and O'donnell, P. (2007) Executive information systems development in an emerging economy. *Decision Support Systems*, vol. 42, no. 4.
- Beck, K. (1999) *Extreme Programming explained: embrace change*, Reading, MA, Addison-Wesley.
- Blaha, M. and Premerlani, W. (1998) *Object-oriented modeling and design for database applications*, Englewood Cliffs, NJ, Prentice Hall.
- Bolloju, N. and Leung Felix, S. K. (2006) Assisting novice analysts in developing quality conceptual models with UML. *Association for Computing Machinery. Communications of the ACM*, vol. 49, no. 7, 108.
- Braa, K. and Vidgen, R. (1999) Interpretation, intervention, and reduction in the organizational laboratory: a framework for in-context information system research. *Accounting, Management and Information Technologies*, vol. 9, no. 1, 25–47.
- Brinkkemper, S. (1996) Method engineering: engineering of information systems development methods and tools. *Information and Software Technology*, vol. 38, no. 4, 275–280.

- Burchell, S., Clubb, C., Hopwood, A. G., Hughes, J. and Nahapiet, J. (1980) The Roles of Accounting in Organizations and Society. *Accounting, Organizations, and Society*, vol. 5, no. 1, 5-27.
- Checkland, P. B. (1981) *Systems thinking, systems practice*, Chichester, Wiley.
- Coleman, D., Arnold, P., Bodoff, S., Dollin, C., Gilchrist, H., Hayes, F. and Jeremes, P. (1994) *Object-Oriented Development The Fusion Method*, Englewood Cliffs, Prentice Hall, Inc.
- Couger, J. D., Adelsberger, I., Borovits, M., Zviran, M. and Motiwalla, J. (1990) Commonalities in Motivating Environments for Programmers/Analysts in Austria, Israel, Singapore and the USA. *Information & Management*, vol. 18, 41-46.
- Dagwell, R. and Weber, R. (1983) Systems Designer's User Models: A Comparative Study and Methodology Critique. *Communication of the ACM*, vol. 26, no. 11, 987-997.
- Dahlbom, B. and Mathiassen, L. (1993) *Computers in context: the philosophy and practice of systems design*, Cambridge, MA, Blackwell.
- Delong, D. W. and Fahey, L. (2000) Diagnosing cultural barriers to knowledge management. *Academy of Management Executive*, vol. 14, no. 4, 113-127.
- Ferranti, M. (2004) Going Abroad. *InfoWorld*, vol. 26, no. 10, 39-43.
- Fitzgerald, B., Russo, N. L. and Stolterman, E. (2002) *Information Systems Development - Methods in Action*, London, McGraw-Hill.
- Goldkuhl, G. (1991) *Stöd och struktur i systemutvecklingsprocessen*, Research report in Swedish, Department of Computer and Information Science, Linköping University.
- Goldkuhl, G. (1999) *The grounding of usable knowledge: An inquiry in the epistemology of action knowledge*, Linköping, Sweden, Linköping University, CMTO Research Papers 1999:03.
- Goldkuhl, G. (2002) Anchoring scientific abstractions: ontological and linguistic determination following socio-instrumental pragmatism. *Proceedings of the European Conference on Research Methods in Business and Management (ECRM 2002)*.
- Goldkuhl, G., Lind, M. and Seigerroth, U. (1998) Method integration: The need for a learning perspective. *IEE Proceedings - Software*, vol. 145, no. 4, 113-118.
- Hevner, A. R., March, S. T., Park, J. and Ram, S. (2004) Design Science in Information Systems Research. *MIS Quarterly*, vol. 28, no. 1, 75-105.
- Hofstede, G. (1980) *Culture's Consequences: International Differences in Work-Related Values*, Newbury Park, Sage Publications.
- Hofstede, G., Neuijen, B., Ohayv, D. D. and Sanders, G. (1990) Measuring Organizational Cultures: A Qualitative and Quantitative Study across Twenty Cases. *Administrative Science Quarterly*, vol. 35, 286-316.
- Huang, Z. and Palvia, P. (2001) ERP implementation issues in advanced and developing countries. *Business Process Management Journal*, vol. 7, no. 3, 276-284.
- Iivari, J., Rudy, H. and Klein, H. K. (2001) A dynamic framework for classifying information systems development methodologies and approaches. *Journal of Management Information Systems*, vol. 17, no. 3, 179-218.
- Jayaratra, N. (1994) *Understanding and evaluating methodologies*, London, McGraw-Hill.
- Kankanhalli, A., Tan, B., Wei, K.-K. and Holmes, M. C. (2003) Cross-cultural differences and information systems developer values. *Decision Support Systems*, vol. 38, no. 2, 183-195.
- Karlsson, F. (2005) *Method Configuration - Method and Computerized Tool Support*. Department of Computer and Information Science. Linköping, Linköping University.

- Karlsson, F. and Wistrand, K. (2006) Combining method engineering with activity theory: theoretical grounding of the method component concept. *European Journal of Information Systems*, vol. 15, 82-90.
- Kumar, K. and Bjorn-Andersen, N. (1990) A cross-cultural comparison of IS designer values. *Communication of the ACM*, vol. 33, no. 5, 528-538.
- Levine, R. (1997) *A geography of time: The temporal misadventures of a social psychologist*, New York, Basic Books/Harper Collins.
- March, S. T. and Smith, G. F. (1995) Design and natural science research on information technology. *Decision Support Systems* 15.
- Morgan, G. (1986) *Images of Organization*, Newbury Park, Sage Publications.
- Nilsson, A. G. (1995) Evaluation of Methodologies for Information Systems Work, A Historical Perspective. IN DAHLBOM, B. (Ed.) *The Infological Equation Essays in Honor of Börje Langefors*. Gothenburg, Göteborg University.
- Pati, R. (1973) *The Arab Mind*, New York, Charles Scribner's Sons.
- Pettigrew, A. M. (1979) On studying organizational cultures. *Administrative Science Quarterly*, vol. 24, no. 4, 570-581.
- Pries-Heje, J., Baskerville, R. and Hansen, G. I. (2005) Strategy models for enabling offshore outsourcing: Russian short-cycle-time software development. *Information Technology for Development*, vol. 11, no. 1, 5-30.
- Rumbaugh, J. (1995) What is a method? Rational Software, Inc.
- Russo, N. L. and Stolterman, E. (2000) Exploring the assumptions underlying information systems methodologies: their impact on past, present and future ISM research. *Information Technology & People*, vol. 13, no. 4, 313-327.
- Sakthivel, S. (2004) Virtual workgroups in offshore systems development. *Information and Software Technology*, vol. 47, no. 5, 305-318.
- Schwaber, K. and Beedle, M. (2001) *Agile Software Development with Scrum*, Upper Saddle River, NJ, Prentice Hall.
- Stolterman, E. and Russo, N. L. (1997) The Paradox of Information Systems Methods -- Public and Private Rationality. *The British Computer Society 5th Annual Conference on Methodologies*. Lancaster, England.
- Trompenaars, F. (1996) Resolving International Conflict: Culture and Business Strategy. *London Business School*, vol. 7, no. 3, 51-68.
- Walsham, G. (2001) *Making a World of Difference, IT in Global Context*, Chichester, Wiley.
- Walsham, G. (2002) Cross-cultural software production and use: a structural analysis. *MIS Quarterly*, vol. 26, no. 4, 359-380.
- Walsham, G. and Sahay, S. (1999) GIS for District-Level Administration in India: Problems and Opportunities. *MIS Quarterly*, vol. 23, no. 1, 39-66.
- Webb, W. (2004) Coding goes global. *EDN*, 58,60.
- Yin, R. K. (1994) *Case study research: design and methods*, Thousand Oaks, CA, SAGE.
- Yourdon, E. (1989) *Modern structured analysis*, Englewood Cliffs, NJ, Prentice-Hall.
- Ågerfalk, P. J. and Fitzgerald, B. (2006) Exploring the Concept of Method Rationale: A Conceptual Tool for Method Tailoring. IN SIAU, K. (Ed.) *In Advanced Topics in Database Research*. Hershey, PA: Idea Group.
- Ågerfalk, P. J. and Åhlgren, K. (1999) Modelling the rationale of methods. In Khosrowpour, M. (Ed.) *Managing Information Technology Resources in Organizations in the Next Millennium*. Hershey, PA, IDEA Group Publishing.

Managerial Perspectives of OSS Enacted Changes in the Finnish Software Industry

Juho Lindman

Helsinki School of Economics, Information Systems Science

juho.lindman@hse.fi

Abstract. Open Source Software (OSS) changes the environment software companies operate in. In this study, we interviewed Finnish OSS companies to outline how they perceive this change. Based on the responses gathered, OSS enacted changes can be grouped into 1) competition environment changes, 2) customer expectations changes, 3) competence changes, and 4) platform changes.

Keywords. Open Source Software, OSS, Free Software, Software Business, Strategy.

1. Introduction

Open Source Software (OSS from here on) has been able to deliver high quality software products like Linux operating system and the Apache Web Server. Those, and many other OSS applications, are nowadays everywhere.

There is, however, a demand for understanding on how OSS changes software business. It has become apparent that OSS is not the enemy. Still, companies are struggling with changes OSS may bring.

This paper aims to investigate OSS business starting from the perspective of an OSS software company. My research problem is "How do the OSS entrepreneurs perceive OSS changes in software industry business environment?". This

approach concentrates on the perspectives of entrepreneurs of OSS companies. This is because their perception is the basis of their decision-making. The aim is to explore and gain empirical understanding on the changes OSS brings.

2. Previous research

OSS based businesses have been claimed to change business environment of the software business. Early research established the field (Raymond, 1999) and concentrated on showing how especially small OSS companies could organize their business (Hecker, 2000). Later on, the focus changed on showing how more established companies could leverage OSS (Fink, 2003) and how research should re-orientate to this change (Fitzgerald, 2006).

2.1 Free or open source software

OSS has roots in the free software movement, which was founded on anti-commercial principles (Williams, 2002). Open source software term was coined to make this potential development and licensing method more interesting to corporate actors (Raymond, 1999). There is still ongoing discussion on the principles software companies should commit when leveraging open source software: for example what are the benefits and losses if community-company relationships are parasitic, commensalistic or symbiotic (Dahlander&Magnusson, 2005).

Even more radically, some authors have viewed OSS as a new kind of social form: a gift culture based on a gift economy (Raymond, 1999). This notion of gift economy as a one-way relationship has been challenged by Bergquist&Ljunberg (2001), who show how giving a gift always includes, and enacts, a social relationship between actors. This relationship should be taken into account when assessing motivations of actors and viability of business.

2.2 Competition environment and digital goods

Porter (1980) has simplified generic strategies into two: 1) differentiation and 2) low-cost. Choices companies face are constrained by industry forces: substitute products, customers, suppliers and above all competitors and possible competitors. We can presume that if an OSS program, process or community is able to change competition environment, then these changes also affect the possibilities companies have. Porter's (1980) five forces are entry of new competitors, threat of substitutes, bargaining power of buyers, bargaining power of sellers, and rivalry between existing competitors.

It seems that Porter's framework is rather pragmatic than analytic. Is it still usable to analyze how OSS can affect business environment? It seems plausible, as Porter (2001) himself uses the five forces analysis applying it on the internet. Porter states that negative trends are problematic: the bargaining power of consumers has increased because of more easily accessible information on products, barriers of entry are reduced because of decreased sales force, more intensive rivalry is a fact because of decreased proprietary offerings, the geographical market has become larger, and pressure to engage in price competition has increased since variable costs have gone down (Porter, 2001).

Software industry produces digital goods that have some distinct characteristics controversial to classical analysis: reproduction and distribution costs are close to zero (Shapiro, 1999). This fact has a tremendous effect on the utilization of the five force analysis on the software industry. Software product companies sink their costs into product development and sales. Logistics and reproducing are not usually very costly. This means that information commodity markets that rely solely on price are not feasible for companies. Basically, it is not possible to compete with a similar product by relying solely in price, if there are two or more companies using the same strategy (Porter, 1985). Product differentiation is needed to isolate profitable markets (Porter, 1985).

In Porter's framework, incumbent companies would seem to have incentive to stop new-comers from entering a selected market (Porter, 1980). Porter (1985) claims that it is possible that development decreases industry attractiveness by affecting the five forces. Porter gives three examples of ways technology might affect industry: it could decrease logistic costs, enhance product performance and thus widen the market, or it could increase interrelations between industries. Open source seems to have done all of the three.

2.3 Customer expectations and digital goods

Shapiro (1999) has pointed out that positive feedback or network externalities are forces strongly affecting competitive situations. Digital products that have network externalities usually have demand-side economies to scale (Shapiro, 1999). Shapiro's theory predicts that managing the expectations of customers becomes very important, since network dominance often leads straight to industry structure re-engineering and thus to revenue.

A factor that makes standards important is the switching cost (Shapiro, 1999). It is possible to entirely prevent competition by increased switching cost. This is a possibility offered by network externalities, and is favored by companies that have lacking technology but strong market and legislative position.

3. Methodology

We have chosen narrative approach to shed light on the research question. Narrative research is any research that uses stories loaded with meaning as a tool to explain phenomenon (Burr, 1995). But these narratives are not just objective reflections of reality - they also shape the events they describe (Burr, 1995). They create social order and load stories with values (Burr, 1995). Similar approach has been used previously to explain OSS discourse from movement perspective: how hackers are constructed, who are the actors and what are the struggles inside OSS and against proprietary software (Szczepanska, 2005).

Narrative research relies on the assumption that by analyzing how stories are told, and what they say and do not say, we can discover something about the world they describe (Burr, 1995). On a more detailed level, stories are a way of explaining companies' actions, since stories shape the social world of the decision-maker. Decisions are made based on how the agent understands the situation and thus acts. Basically, companies are not themselves actors, but their acts consist of the acts of the people who belong to the organization.

4. Data and analysis

We approached three different software companies to find out how they perceived their business environment concerning OSS. These companies did not have anything in common except some experience on OSS. All the companies are partly Finnish in origin. This was to keep the workload manageable. Company A was a small Finnish software company, Company B was a quoted international company and Company C was a large international company.

The method of data collection was semi-structured interviews. Respondents were people participating in companies' strategic decision-making concerning OSS. There is the risk that the respondents might be biased to favor open source software, so to ensure the neutrality of the study, this possibility has to be taken into account. After the research was finished, the respondents were sent their comments and analyses based on them, and their input was asked about it. This way it will be verified that it is their voice, not the researchers.

The interviews took place in a quiet environment and were taped. They lasted for about 45 minutes. For preparation, the respondents were told that researchers were looking for people who have experience in both open source and software business. Furthermore, in the interview it was disclosed that researchers were interested in business effects and OSS. Thematic questions were posed in a non-

leading way in order to guarantee that respondents' voice would be heard. In total six persons were interviewed.

In the beginning of the interviews interviewer introduced himself and gave general theme of the interview. Then respondents were asked for personal work history, their position in the company, and their experience in open source. Then some general company information was gathered. Then interviews proceeded into OSS and competition environment (especially customers and competitors). In the end, there was a possibility to add if something was left out during interview.

5. OSS enacted changes

The narratives the respondents' used in describing the business changes were a mixture of scientific theories, consultant jargon and tried-and-true business practice, but clearly showed how the respondents view their business environment and what their decisions were based on. The narratives describing OSS changes were grouped into competitive changes, customer expectations changes, competence changes, and platform changes.

All the respondents agreed on open source software having characteristics that have the potential to severely change business patterns. Whether or not open source software is able to change the patterns depends on the characteristics of the industry and the actions of other companies. When asked about the effect to industry structure, respondent from company C put it quite well: "*(Entrant) will either totally change the industry or have no effect at all. It depends on the state of the industry.*"

There was a clear tendency to talk about services, not products, among all the respondents. Partly this can be attributed to the fact that their companies sold services – but it is also apparent that they did see the future of software business in services rather than in commoditised products.

5.1 Competitive changes

Competitive changes explained business changes by competitors' actions. There were clear market orientated narratives – in fact, these were the prevailing ones when talking about business effects. All the respondents talked at some point about open source software that is in competition with proprietary software. This underlines the importance of understanding the changes in the rules of the business environment.

All the respondents agree that proprietary software cannot compete very long in the same market with similar open source software. There are several clear reasons. The obvious one is, as respondent C put it, *“the business will have a fierce price war, where profits disappear.”* The respondent from company B describes the dilemma: *“I have looked at that (an entry of open source customer software) from a proprietary company’s viewpoint and it was a quite difficult situation. The question was: How could we differentiate, when the open source software was able to mimic all the features on the long run. Basically we could have put more money in R/D and try to develop more features and such or then we could have gone with the open source movement. Neither option was a very good one.”*

This quotation speaks for itself: a company cannot go into a price war and mimicking makes differentiation in some cases impossible. The software companies try to do everything in their disposal to not get into this situation. The most obvious way is to block entry. There are several ways to accomplish this. Respondent from company C described some options: *“Hire the best developers from that rival to kill the project. If that cannot be done, then prepare to start an uphill battle. Microsoft and other large US companies have used FUD (fear, uncertainty, doubt) to diminish the entrant, but that has actually given entrants more visibility”*. A company A respondent forecasted similar approaches: *“Some people have believed into these FUD-buy talks”*. Another respondent continued: *“Microsoft has announced that open source is like a cancer that is spreading.”* This “FUD-process” is obviously directed to change customer expectations.

The respondents agree that the development towards open source software products will not happen in all business environments, since it puts quite heavy demands on the open source community. This kind of development requires a commoditised product and many developers – all the respondents did however agree that, for example, operating systems and some other most used programs will probably be open source in the future. Respondent of company C speculated *“Open Source will erode the great margins of the widely used software packages and will force the providers of those packages into service business.”* On the other hand, all the respondents agreed that proprietary software products would not disappear, since open source software products need some special circumstances – at least quite many users and developers.

The customers’ needs affect whether there is a possibility of an open source software entry. For example, a respondent of Company B stated that since his company operates in an environment where trust to the company is the key, products cannot fail, and price is not that important, there was a very small chance of an open source entry. The only possible threat would be that some of

the competitors together or alone would open their software, but there would have been no gain for anybody should they have done so. They could only lose their customers and revenue.

The respondent of company C stated that the probability of an open source software entry depends on how the companies in the market create their revenue. If their revenue creation is based only on the product, then there is a high probability of entry, but if their revenue creation is based on services, then an entry is less likely. This is because a product can be more easily commoditised than service.

The respondents use the concepts locking-in and locking-out quite freely – it was not apparent what things they meant by them or what exactly caused the locking-in or locking-out. All the respondents had in mind that locking means forming a relationship between the buyer and the supplier, and that there are consequences to the buyer making similar acquisitions next time. These consequences could be for example financial, compatibility issues or expertise issues.

One of the strengths the incumbent companies have and will use is the switch-in costs - once you buy something from one supplier, it becomes more costly to buy them from some other vendor the next time. Incumbent companies often try to lock the entrant out. Even by giving away some of their software in order to take down rival companies. A respondent of Company A describes this process against their own open source software company: " *We tried to create our own market with open source software and selling service. Our competitors responded by starting to give away their software.*" The company had anticipated this and was able to survive – it had spotted an existing market and entered it, forcing incumbent companies to react. And when the situation has gone this far, the incumbent companies do not really have very many good options left.

Locking-out is a good barrier of entry, but it is not unproblematic. As all the respondents agreed, there is less lock-in also in OSS. Since the source code is open, it is possible to continue the development of the program without the supplier or with a different supplier. This makes open source software easier to sell to customers who are becoming more and more cautious of lock-in. Company A also tells the other side of the story: customers become locked-in also with open source software – once the client has selected open source software, it is difficult to change back to proprietary. The users do not get locked in to a certain product – they become locked in to open source software.

But basically it is possible to evade lock-in to one company, if there are several open source vendors operating on a same platform. There is one catch here too:

assuming that software product is evolving and there are several developers that sell customisation and one company that coordinates project. If a company does not buy from the coordinator, but some of its rival suppliers, then *“how can he be sure that he can use the bought customised features also in the future versions?”* underlines the respondent from company A.

Company C’s respondent also urged all the companies in software business to take their rivals seriously: *“And make sure that your software is of high quality and your company is considered ethical, so people don’t want to take you down. If your software quality is low and development cycle long, then there will be someone challenging you, and that might be an open source competitor”*. All the respondents agreed that no companies are above competition, no matter how well they think they have locked-out their rivals.

5.2 Customer expectations changes

As derived from features of the digital products, customer expectations became very important in the answers. All the respondents agreed that customer expectations determine what solutions are commercially viable. These narratives were called customer expectations changes. The respondents took customer expectations as granted – they implicitly assumed that expectations direct customer behaviour and are thus important to companies.

All the respondents agreed that media coverage has some effect on the sale and thus expectations of the potential users become important. Respondent C even stated that *“Today Open Source is pet of the press”*. The role of images and media is important, since it takes competition to a new level. Products and services do not compete only with differentiable features and solution quality, but also with images and reputations.

This viewpoint is especially interesting when talking about network externalities; as claimed in previous literature (Shapiro, 1999) plausible promises of the future directly affect the sales of today. “FUD” can, in this sense, be viewed as a way of discrediting the open source software in the beginning and deliberately block its development. All the respondents agreed that incumbent software companies have a good motivation to stop “the cancer from spreading”.

Respondents’ common disaffection of some companies’ strategies is a very important characteristic in understanding what open source software is about. It is not a trait of an individual – it is a trait of a community. All the respondents were familiar with the same enemies. Some of the enemies were direct rival firms, but most of them were not. However, the disaffection to these companies was shared. The respondent in company C stated: *“What would be better marketing than the*

Microsoft guy saying: "That software is nothing." In company A the same company's marketing efforts were discussed in more detail:

- *If for example some schools think of starting to use Linux, then Microsoft arrives giving away Windows. And in a few years, after you are hooked, they'll hit you with licence fees.*
- *In my opinion, that resembles closely the way drugs are sold.*
- *The first one is always free. By the way, the same tactic is used by our proprietary competitors.*

Respondents had differences of opinion on who knows best what the customer want. Most of the respondents assumed that customers knew what they wanted in most cases and that this information should guide the development of software products. The way to accomplish this was not discussed very clearly – there were some cases when the elitist narratives came up.

In these cases the customer needed guidance in knowing what he wanted. The helpless customer and the omniscient customer were used in several occasions and in some cases only few sentences apart (from company A): "*If the customers do not understand what the benefits of open source software are, and you bring up that we have this open source software, then they don't understand what you are talking about. They go: What is this, is it not 1-2-3 and we have the operational software?*" as opposed to "*Open source software works in such a way that straight from the beginning, we release it. The users, I mean the real users, can take part in it, and see it.*" In some industries the proprietary companies were seen to have best information on the different customer needs. These needs were categorised differently by different respondents: some talked about technological needs and others about business needs. In some other industries the global reach, high level of penetration and the possibility to develop the product according to tastes were seen to answer better the customer needs.

Another aspect all the respondents brought up was quality. All the respondents used the word quality, but they used it in several different meanings and they apparently had different opinions on what this quality is. All the respondents agreed that quality was something a customer perceived.

A respondent from company A saw that response from the clients made quality possible. He told: "*Often in proprietary software development they live in a basement and tell nobody anything. They possibly take some guys to the basement, quickly sign the NDA's, even without telling what is happening. Like it was something revolutionary they are making. Then, after years of careful craftsmanship, when the product is ready, they climb up and release a ready*

product to the market. The attitude is called We Know What is Good For You. And then they'll sell it, or shove it if necessary, since now they have something great – no matter what the customer really wants". Open source software development is thus done differently and is able to satisfy the needs of the customer better, as it is done much faster and feedback loops are much shorter.

The other view given by respondent B is that software companies basically know what their customers need and are thus able to produce products of better quality. This is true for those software companies that have a large contact network – their salespeople see the problems of the customers from a larger perspective. The respondent from company B urged however the proprietary companies to keep up this competence – in the long run, open source rivals could very well catch them up. There is also the question of testing – it is much more demanding to do open source software development on a critical system, since it really cannot be allowed to crash in order to produce the necessary feedback to programmers. Respondent B also highlighted the need for product quality, but also the support services quality.

In company A there was some controversy about communicating with clients – although the company underlined in its media relations that it was open source software company, it did not automatically tell this to its customers. In some cases it was thought that it does not really matter that a customer is buying an open source product – *"it is no big deal"*. Company B that uses an open source platform in its main product, is quite hushed about it. This is quite interesting, as it tells that there is some prejudice or at least lack of information concerning open source software. Perhaps it means that some of the "FUD" has some basis or at least it has been thought to be credible by the customers. And the customers buy the products or the services that create the revenue for these companies.

Credibility in the eyes of the customer was another thing the respondents were interested in. Company A stated that originally one of the reasons they started making open source projects was that it provided them with credibility. Their competitors were many times larger and had a lot of resources to use in marketing. *"We got credibility from the open source community. It was a fact that we were international and our product was used all around the world by thousands of users. The product was backed up by companies and institutions."* On the other hand, a respondent from company B stated that in their product market, the potential open source companies would have a very hard time becoming credible. *"We are facing all the time the most important issue – the issue of credibility. The company behind the product has to be credible"*. Since the systems sold are critical, the companies sell security. The community could not guarantee this security, since the customers trusted much more the companies,

according to the respondent. The credibility thus depends heavily on the characteristics of the product, the credibility of competitors and what is necessary to become credible in some market.

Several respondents took up the question about the price of open source software. These narratives as such were not very interesting, unlike anticipated. The potential, or even analytical, price difference was not seen as being crucial – the respondents agreed that it was only a small part of the total cost of ownership. All the respondents seemed to agree, that the price was not the key motivator for the customers, at least not in their industries. However, respondent from company B claimed that one of open source software's strengths is that in most cases it is the most cost efficient solution. *“Some proprietary software companies claim, and in some cases quite correctly, that the total cost of ownership is less for proprietary products. In some cases it is, but in some others the price favours very clearly open source software.”* Also in this case the price was seen as a method of marketing, not as a direct determinant of customer behaviour. But as an example, this proprietary company is quite interesting, since it would seem to have been quite sure in its marketing that price would interest the buyers.

5.3 Competence changes

Respondents used competence changes to explain some business effects. The main point was that open source software development needs some special competencies. The number of people competent to make open source software is growing rapidly and this makes open source software development more rapid. The environment where services are becoming more important than products also favours competencies – locking-out is based on competence of the developer company rather than on copyrights or direct expenses.

Especially in Finland there are a lot of people that can be recruited and who know about open source software. This is a factor that supports the development of open source programs. Respondent B claimed that *“Five years ago, it was very hard to find competent people for open source software. Today you can find more specialists in Finland for any 100 most popular open source systems than for any proprietary systems, excluding 10 most popular software products.”* Especially in Finland, IT-specialists who write code very close to operating systems have also actively taken part in the development of open source software programs. Later on, the respondent pointed out that above mentioned numbers were based on intuition, and could not as such be trusted without checking. Respondent B believes that since Finnish universities are using open source software to teach how to code, the know-how will diffuse rapidly – the more know-how there is, the more the software companies will find uses to that know-how.

The competencies are also becoming more important in the competition. A respondent from company A stated *“If the client wonders who is the best provider of some customised service to the software, then it has to be the original coder, the developer. If there is a problem, he is the best one to fix it – not some forker from internet. We can compete with the fact that we are the experts of this software”* This way the company really does not have any other assets than know-how. The code is out, so basically anyone can study it, modify it a bit and start selling it. The competitive advantage a company has or has not thus comes only from the competencies of their experts – not for example from copyright.

Competency also gives some protection from competition. A respondent from company A continues: *“That is why we are not so worried about competition even if we have open source software products. We have half a year’s head start compared to anyone who would try to do what we are doing.”* This head start is partly technical as the company has coordinated the development of their software products and can offer superior technical support. But the company also has a reputation that can be used in marketing. An entrant that would start from scratch would not have these.

It is necessary to note that these figures and trends towards open source software and there being more specialists in the field are in fact difficult to measure – but they are opinions of the experts, who also have observed the open source community. They should not however be taken as the truth as such, especially since all the respondents were at least a bit open source orientated.

What is fundamentally interesting is the way the respondents saw copyrights as protection for some more traditional companies. These incumbent companies have the option of using copyrights of software to block newcomers that have technologically competence and superior products.

5.4 Platform changes

The respondents talked about platform changes when they talked about creating new markets. These platforms are technical and judicial, but the main point was that they are something that enables business. When solutions share the same platform, there is a market for goods. All the respondents viewed open source as a good way to create platforms rather than as a way to create products. The open nature of platforms means that they are more effective in some circumstances – especially when it is critical to know how the platform operates. The respondents talked about open source software products, but in such a way that open source software was a part of the service or a platform to the service. All the respondents agreed that open source software enables selling some other product.

Another common example of a platform was an operating system. A respondent from company B said explicitly that they needed an open source operating system under their product so that they could guarantee that it would be reliable. A proprietary operating system simply would have been too high a security risk, since they needed to know how the system works and participate in the development if the solutions were not elaborate enough.

Respondent B also saw open source software as a potential mode of co-operation between companies in order to save costs. *“Several companies could work together to create open source software for existing needs. This would be more efficient than if all the companies bought the same work and told nobody about it”*. The respondent from company C agreed with this idea of co-operation and also saw the potential for savings. The respondents considered it a real possibility to create a market with open source software and invite entry to the market. The companies would do this deliberately – and they would probably not care if some other field of business would suffer in the process. The company that originally created the open source software would also participate in the same market with a clear advantage: they would have the original developers in their payroll. Company A viewed this as their real strength – they had the original developers, so they had the know-how to compete with. Respondent C also saw a clear problem in this market making: *“Anyone can compete with services, when there is no vendor lock-in by software. An entering company could hire 10-15 best people from the market. Then there would be a service provider, who has less overhead and less expenses, who could offer same service with lower price or even outsource some services to cheap labour countries. The original service provider would be in trouble.”*

5.2 Respondents comments on findings

Respondents were given the possibility to comment the results. The main aim was to make sure that it was the respondent’s voice speaking, not the researcher’s, and that the research had been done according to their opinions and preferences.

All the companies sent comments. All agreed that they had been quoted correctly and that the narratives, and conclusions based on them, were correct. The interpretation of the researcher was seen as justified and it was accepted. All the respondents had some comments on some issues raised in the study.

The respondent from company B stated that his speech was quoted correctly. He pointed out that his quote on the large number of software developers in 100 most used open source programs were based on intuition rather than statistics and therefore should be taken with a grain of salt. The respondent B also wanted to stress that open source as a platform enables finding niches in the markets, since

the necessary investments can be lower. The respondent wanted to underline that thus it is not necessary for a starting software company to conquer an already inhabited marketplace.

The respondent from company C stated that he would have stressed some things differently, but that there was nothing ultimately incorrect in the research. He also stated that he did not agree with all the results, but that his speech was quoted correctly. The respondent from company A accepted the interpretation and did not see anything wrong about the conclusions, although he admitted that some of the opinions had developed changed after the interview.

Respondent A also clarified his views on the membership of the community: “Members are the 1) developers, 2) users, who acknowledge the existence of developer community, and 3) service providers who acknowledge the developer community and admit to being a part of the community.” Thus “service providers who simply use an open source product as a part of their products or sells open source software products without informing their customers and taking part of the discussions shaping the software, are really not members of the community”. “The community members are those agents that recognize and admit belonging to the community and who have influence on what the community is.” This view is different from the other respondents. This notion is quite interesting, but unfortunately there is not enough data to draw further inferences about it. The respondent of company A however makes it clear that there is some disagreement on who is a member and who is not.

6. Results and discussion

Respondents agreed that there are changes in the perceived business environment as speculated by Porter (1980). First, 1) proprietary products cannot compete very long in the same market with open source products and thus try to prevent their entry. This blocking out of potential rival companies becomes imperative and it can be accomplished by using media targeted marketing tactics, different kinds of lock-ins or copyrights strengthened by lawsuits to shield the market from the entry. Second, 2) as theorized by Shapiro (1999), customer expectations become important. This is linked to the first result, but also highlighted by the necessity to become credible and produce quality. These words were used quite loosely, but all agreed that they were important. Surprisingly price did not seem to be very interesting to the respondents. Third, 3) competencies will become more and more necessary, since the markets will turn from products to services and copyrights will no longer protect the companies making open source. It was also noted that such competencies are much better available today than for example

five years ago. Fourth, 4) it will be possible to create new markets and necessary to invite entry to them, but also to use common platforms as a way to co-operate.

The media's powerful role in open source software came up already in the beginning – the media's strong role in creating expectations, but also in creating coherence to the open source community by telling the tale of Linux with an interesting plotline. The media's role was also one of interaction – the respondents did not settle for what it told them, but questioned the stories. Respondents also considered it important to shape the way the tale of open source software is told in the future.

The history and the “must” books of the movement were known to the respondents and they could tell the tale spicing it up with their own experiences. The powerful notion of freedom also comes into play and has a direct effect to company strategies and policies – what and whose freedom to offer and respect.

This explorative study opened several interesting routes to continue the research. The exact nature of the business effects is one the most interesting. The locking-out and locking-in mechanisms could have interesting managerial implications. Different media strategies of software companies, including “FUD”, would be quite uncharted territory for investigation. The competence issues have many sides, and this work has only scratched the surface of the issues related to the changing competence needs of software companies. The discussion about software products versus software services would also probably yield interesting results.

It would also be interesting to hear the proprietary software company's voice in the issue of the open source software phenomenon and to compare it to the narratives used by the open sourcists. Would there be similarities and why?

We speculate on the still deepening interaction of the community and business. It has been claimed that OSS would be severely altered by business users moving into OSS scene. An interesting question would be see whether it is the OSS scene that is changing - or in fact the software business?

On a more general level, there has been a discussion concerning a networked way of life and changing the requirements of work, economy, and society. These views were not explicit in this paper, but they came up – especially in a discussion about the digital ownership, co-operation outside market structures, and in the premises of the business strategy.

8. Summary

The research question was “How do the OSS entrepreneurs perceive OSS changes in software industry business environment?” The answers to can be divided according to respondents into four changes in business environment: 1) competitive changes, 2) customer expectations changes, 3) competence changes, and 4) platform changes.

References

Bergquist, M. & Ljunberg, J. (2001). "The power of gifts: organizing social relationships in open source communities". *Information Systems Journal*, 11, 305-320.

Burr, V. (1995). *An introduction to social constructionism*. Routledge. London.

Dahlender, L. & Magnusson, M. (2005). "Relationship between open source software companies and communities: Observations from Nordic firms". *Research policy*, 34, 481-493.

Fink, M. (2003). *The Business and Economics of Linux and Open Source*. PH PTR. Prentice Hall. Upper Saddle, NJ.

Fitzgerald, B. (2006). "The Transformation of Open Source Software". *MIS Quarterly*, 30 (4), 587-598.

Hecker, F (2000). *Setting up shop: the business of open-source software*, <http://www.hecker.org/writings/setting-up-shop>

Porter, ME. (1980) *Competitive Strategy*. Free Press. New York.

Porter, ME. (1985) *Competitive Advantage*. Free Press. New York.

Porter, ME. (2001). "Strategy and the Internet". *Harvard Business Review*, March 2001.

Raymond, Eric S. (1999). *The Cathedral and the Bazaar, Musings on Linux and Open Source By an Accidental Revolutionary*. O'Reilly & Associates, inc. Sebastopol. CA, 1999.

Shapiro, C& Varian, H. (1999). *Information rules: A Strategical Guide to the Network Economy*. Harvard Business School Press, Boston Massachusetts.

A.M. Szczepanska, M. Bergquist and , J. Ljunberg. (2005). "High Noon at OS Corral: Duels and Shoot Outs in Open Source Discourse". In: J. Feller, B. Fitzgerald., S. A. Hissam, and K. R. Lakhani. eds. *Perspectives on Free and Open Source Software*. MIT Press, Cambridge, Massachusetts.

Williams, S. (2002). Free as in Freedom: Richard Stallmans Crusade for Free Software. O'Reilly, Sebastopol CA

Balancing Technological and Community Interest: The Case of Changing a Large Open Source Software System

Thomas Østerlie and Letizia Jaccheri
Norwegian University of Science and Technology

Abstract. This paper studies the process of rewriting and replacing critical parts of a large open source software (OSS) system. Building upon the notions of installed based and transition strategies, we analyze how the interaction between the OSS and the context within which it is developed and used enables and constrains the process of rewriting and replacement. We show how the transition strategy emerges from and continuously changes in response to the way the installed base is cultivated. By demonstrating a mutual relationship between the transition strategy and the installed base, we show how the transition strategy in this particular case changes along three axes: the scope of the rewrite, the sequence to replace existing software, and the actors to be involved in the process. The paper is concluded with some implications for how to study the process of rewriting and replacing OSS.

Keywords. Open source software development. Rewrite and replacement. Transition strategy. Installed base.

Introduction

Parallel development, a rapid release schedule, actively involved users, and prompt feedback are described as key characteristics of open source software (OSS) development (Feller & Fitzgerald 2002). Empirical studies of OSS development

have therefore primarily focused on the cyclic process of corrective and adaptive maintenance (German 2005), its organization (Crowston & Howison 2005), and analysis of the products of this process (Paulson et al. 2004, Samoladas et al. 2004, Mockus et al. 2002). Describing the process of rewriting the FreeBSD kernel, Jørgensen (2001) shows that unlike the discretely delineated tasks of adaptive and corrective maintenance, rewriting OSS is a longitudinal process that does not lend itself well to parallel development, rapid release schedule, and active user involvement. While we know that large and successful OSS products are rewritten—for instance the original Apache code was rewritten and replaced with a modular design in 1995, and several large subsystems of the Linux kernel, like virtual memory handling, have been rewritten and replaced throughout the kernel's life cycle—we find that rewriting and replacing is an underdeveloped topic within OSS research.

Building upon Jørgensen's (2001) work, we study the repeated attempts at rewriting and replacing a core OSS system. The empirical basis for this paper is a study of the Gentoo Linux distribution. The background for the study is that the Gentoo package manager, the core of the Gentoo Linux distribution "is very fragile [because it has] evolved rather than being designed", as one of the Gentoo developers puts it. Studying the attempts at rewriting and replacing the package manager provides an excellent opportunity to study the problems associated with rewriting and replacing critical parts of a large OSS system. To this end, we ask: How does the interaction between the OSS and the context within which it is developed and used enable and constrain the process of rewriting and replacement? In this paper we analyse this by studying the relationship between the installed base and transition strategies (Hanseth and Monteiro 1998) in the process of rewriting and replacing the Gentoo package manager.

The remainder of the paper is structured as follows. The second section motivates the study of rewriting and replacing OSS through the notions of transition strategies and installed base. These two terms are elaborated. The third section outlines the case; presenting the research setting, as well as describing three attempts at rewriting and replacing the package manager. In the fourth section we discuss the case along two dimensions that surface in the case: the issue of resources and transition strategies as a process. The final section contains concluding remarks, where we describe how we have addressed the research question and implications of our findings to the study of rewriting and replacing OSS.

Methodologically, the paper is based on an interpretive case study (Klein & Myers 1999) of the Gentoo OSS community. The data was primarily collected during a ten months programme of participant-observation conducted from March to December 2004. Since the OSS community is geographically distributed, participant-observation took the form of observing and participating on the Internet Relay Channels (IRC) that the community use for communication, by

submitting and resolving failure reports, as well as contributing with code. Throughout the period of fieldwork the IRC channels we participated on were logged to disk; one file each day for each IRC channel totalling 1027 files. A key informant also provided us with his IRC logs, stretching back to April 2003. No formal interviews of participants in the OSS community were undertaken, although informal talks with participants—both on e-mail and on IRC—were conducted on a regular basis to test our informal theories about the fieldwork. 71 documents were collected throughout the period and organized in a documentary database. Online data sources that provide static data were surveyed. These include the Gentoo bug tracking database, the Gentoo mailing list archives, and the Gentoo revision control system. As the Gentoo Web site is under revision control, relevant documents from this Web site were not organized in the documentary database. Instead, we decided to rely on Gentoo's revision control system. This archival material provided us with data from 2002 to the end of 2005. A more thorough presentation of the research is provided in (Østerlie and Wang 2006).

Theory

Jørgesen (2001) describes the process of implementing symmetric multiprocessing, a significant new feature, in the FreeBSD operating system kernel. Although the paper describes in detail the practical arrangements for making the significant change and folding it into the main code base, the paper tells little about the context and rationale for organising the process this way. However, the paper provides little information about how the OSS developers decide upon the specifics of this process of going from one version of the software to other. We expand upon Jørgensen's (ibid.) work, by examining how OSS developers make such decisions. We do so by analysing the OSS an information infrastructure (II) (Hanseth and Monteiro 1998), studying the process of rewriting and replacing the Gentoo package manager in terms of transition strategies and installed base.

Transition strategies

The transition strategy is a plan outlining how to go from one stage of the II to the other (Monteiro 1998). However, the transition strategy is caught in a dilemma, "where the pressure for making changes ... has to be pragmatically negotiated against the conservative forces of the economical, technical, and organizational investments in the ... installed base" (ibid., p. 230). Controversies over a transition strategy are therefore negotiations about *how* big changes can—or have to—be made, *where* to make them, and *when* and in *which* sequence to deploy them.

Whereas Jørgensen (2001) describes the sequencing when rewriting a clearly delineated part of the software, thinking in terms of transition strategies enables us

to study the larger process of rewriting software encompassing what is to be rewritten and the scope of the changes, important factors in the process of rewriting the Gentoo package manager.

Installed base

The installed base can be defined as the interconnected technologies and practices that are institutionalised in an organization (Hanseth and Monteiro 1998). Adopting this view, we see that changes cannot be made to software artefacts in isolation, but must always take into account the other elements of the installed base that the artefact is connected to.

This points towards two important elements when thinking in terms of installed base. One, IIs must evolve by extending and improving the existing installed base, or *cultivating the installed base* as it is called (ibid.). Two, as IIs grow, it becomes increasingly hard to extend and improve it because of the many elements that have to be changed in the process. This is called the *inertia of the installed base* (ibid.).

Actor-network theory

Like II, actor-network theory (ANT) is the underlying ontology for this study as well. We therefore mobilise a limited ANT vocabulary inscribed in and circulated by Callon (1986) and Latour (1987) for the case description and analysis of this paper. Well aware of recent movement toward fluids and fiery objects both within ANT and IS research, we choose to mobilise this vocabulary as it translates well our interest in bringing forth the chronic tension of multiple and at times contradictory interest in cultivating the Gentoo installed base.

A major focus of ANT is to provide a way of tracing and explaining the process of how networks of actors, *actor networks*, become more or less stable through the alignment of interest. Particular to ANT is that the notion of actors encompasses both human and non-human actors such as software technologies, documents, and so on.

The process wherein networks of aligned interest are created and maintained, is called *translation*. Through the process of translation the translating actor defines other actors, endowing them with interests and problems to be overcome. By framing a problem in such a way that it determines a set of actors, the translating actor defines and aligns the other actors' interests with his own (Callon 1986). The problem is framed in to establish the translating actor as an *obligatory passing point* by enrolling and mobilising the other actors to pass through this point to achieve their interests.

Translation is therefore the process of enrolling a sufficient body of actors by aligning these actors' interests so that they are willing to participate in particular ways of acting. It implies definition, and this definition is *inscribed* in material

intermediaries (Latour 1986). These intermediaries are actors in their own right. They are delegates who stand in for and speak for particular interests; they are the medium in which interests are inscribed. The operation or translation is therefore triangular: it involves a translating actor, actors that are translated, and a medium in which the translation is inscribed.

The Case of Rewriting and Replacing Portage

GNU/Linux distributions, complete operating systems that integrate the Linux operating system kernel with a collection of software libraries and applications, are an intrinsic part of the success of Linux. Since the beginning of the Linux kernel development in the early 1990s, communities of OSS developers have created GNU/Linux distributions. As GNU/Linux distribution consists of thousands of different software libraries and applications, distribution developers primarily repackage third-party OSS, doing whatever adaptations required for the third-party software to function on their specific GNU/Linux distribution. At the time of writing, there are over 300 Linux distributions, large and small—some developed commercially, others developed by volunteers—registered with the DistroWatch (2006) Web site. In this paper we report from a study of the OSS community developing the Gentoo Linux distribution, rated by DistroWatch among the ten most widely used distributions.

Starting out as a one-man volunteer project in 2000, by 2003 the number of volunteer Gentoo developers had grown to over 200. The number of third-party software libraries and applications, collectively labelled packages, supported by the Gentoo Linux distribution had also grown. From being a GNU/Linux distribution, Gentoo had over time been turned into a generalized software system for distributing OSS software packages for different Unix operating systems like BSD and MacOS. By 2003 Gentoo suffered increasingly from growth pains.

Organizationally, the Gentoo developers addressed the growth pains by introducing a formal management structure in June 2003: "The purpose of the new management structure is to solve chronic management, coordination and communication issues in the Gentoo project" (GLEP 4). Technically, by mid-2003 growth pains were putting a strain on the Gentoo package manager, Portage, the software that integrates packages on local Gentoo systems. It is from the repeated attempts at rewriting and replacing the package manager that we report in this paper. Although all of the Gentoo developers can agree that the package manager needs to be rewritten and replaced, this turns out to be problematic. After numerous attempts, the Gentoo developers give up. Why is it that they fail to rewrite and replace the package manager? We provide an overview of these attempts in the rest of this section, before we address the above question during the discussion in section 4.

First attempt

It is mid-November 2003. Four developers make a forceful declaration of intent during the biweekly Gentoo managers' meeting: "We are aggressively working on plans for next generation Portage, which is not going to simply be a rewrite or a new version but beyond people's wildest expectations". The source code of the current version of Portage "is very fragile [because it has] evolved rather than being designed". It has become difficult to comprehend and maintain, preventing the Gentoo developer community at large from participating in developing and maintaining the package manager. Currently, only a "small group [of Gentoo developers] really know how to make significant contributions to the code".

To enrol the Gentoo developer community with the rewrite effort, the four developers provide an architecture diagram (see Figure 1). The diagram graphically lays out the main parts of the package manager, the interface between these parts of the system, and which features will be supported as components.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Figure 1 Portage-ng architecture diagram

By rewriting Portage with a core system and "a solid API for components [where] major parts that are now core Portage are going to be implemented as components", the four developers explain, "components can be developed by different teams [of Gentoo developers]", turning Portage into "a true community project". To achieve this end, they continue, Portage "is not just to be 'robust enough' but incredibly reliable".

The architecture diagram serves to meet the interests of two other actors. Performance of the package manager has been a point of discontent among the people administrating Gentoo systems. Furthermore, a number of Portage-specific applications that are part of the Gentoo software distribution operate directly on Portage's database and configuration files. A recurring problem with changing the format of these configuration files and databases, is that some of the Portage-

specific tools cease to function. To meet these interests, the four developers are developing a prototype of the core system.

The prototype is realized in GNU Prolog, as this programming language can meet the above interests. Prolog can provide "robust, provably correct code". GNU Prolog has an API for components to be written "in C for performance when needed". However, the final choice of realization language is to grow out of the requirements. "Right now," the four developers explain, "we are at the blueprint stage ... the plan is to get a solid blueprint, then make it a community project at the earliest possible point". While the four develop the blueprint and the prototype, they enrol the Gentoo developer community at large to formulate requirements for the rewrite.

No one in the community questions the rationale for rewriting Portage from scratch with a modular architecture. However, the choice of Prolog for a prototype produces resistance. How can Prolog resolve the problem of performance, when "Prolog could be very slow"? one developer asks. Also, how can Portage be turned into a true community project when only very few Gentoo developers are familiar with the predicate-logic programming paradigm of Prolog? The choice of realization language will produce a high entry-barrier, some developers argue.

The promised Prolog prototype fails to manifest, and in mid-December 2003 a competing prototype realized in Ada appears. Throughout November and December the four developers planning to rewrite Portage keep on trying to enrol the Gentoo developer community with their plan by pointing out time and again that the choice of realization language is to emerge from the requirements. However, instead of formulating requirements, the Gentoo developer community delve into endless discussions about the best programming language for rewriting Portage.

By February 2004 all activities on this attempt to rewrite Portage have ceased.

Second attempt

On February 18 2004 a new CVS module called Portage-mod is imported into the Gentoo CVS repository with the following note attached: "All current work between me and George moved from remote cvs to Gentoo cvs!". Where Portage-ing is a complete rewrite of Portage from scratch, Portage-mod is an effort to take the existing Portage code and modularize it. Niles, a Gentoo developer, is heading the effort with help from George, a newcomer to Gentoo and not yet an official Gentoo developer.

While Niles is modularizing the existing Portage source code, George will help writing unit tests. According to the README file imported with the CVS module, the plan is that the "[d]evelopment of a package structure should facilitate the later development of an consistent Portage API, development of this API is part of this

project and development should ... begin once Portage modularization is done and a unit testing framework is done."

Development on Portage_mod is undertaken in parallel with the continued development and maintenance of Portage. When the code is modularized, the plan is to rework changes made to Portage during the period of modularization into the modularized version. However, it turns out that the changes made are too significant to achieve this, and this second attempt at rewriting and replacing Portage is laid to rest.

Interlude

"I have a feature request for you", Bob states on the Portage developers' IRC channel. It is mid-April 2004. Bob is a newcomer to the Gentoo community, having only recently been adopted by the Gentoo community to introduce web application support for Gentoo. "The configuration tool for web applications need to edit the Portage database," he continues, "so that a single web application may be installed multiple times on different locations in the file system. " The Portage developers cannot see the purpose of such functionality. A discussion ensues. In the end Bob argues that if the Portage developers cannot provide this functionality for him, he cannot provide support for web applications in Gentoo. Reluctantly the Portage developers agree with Bob about a technical solution to address his requirements.

Third attempt

In wake of the second attempt at rewriting Portage, the remaining developer from that effort sets out to write an API on top of the existing implementation of Portage. There is unanimous support for this effort among the other Gentoo developers. The effort, while a continuation of parts of the second attempt at rewriting Portage, also enrolls the interests of two other developers who have been working to establish an API to insulate Portage-specific applications from Portage's configuration files and databases. This will solve the recurring problem of these applications breaking when the format of the configuration files and databases are changed. Furthermore, the API will insulate the core functionality of Portage, so that after the API is in place modularization of Portage may find place without disrupting users.

Work on this third attempt at rewriting Portage ceases after a month and a half. The developer working on the API explains the situation:

The whole API was designed around a single using application [that] would instigate the reading of the configuration, etc. ... that doesn't fit in at all with distributed computing and/or remote management [which is something] people will ask for and/or want to implement themselves down the track. [It is therefore] better to preempt it now than find we've shot ourselves in the foot later.

The new approach for Portage is to completely rewrite it with a core running as a Unix daemon with user applications calling the daemon remotely.

Upon the first author ending the fieldwork in December 2004, there are two independent efforts at rewriting Portage. One effort by a young engineering student who has rewritten the core Portage functionality in C, who fails to attract the Portage developers' attention. Another effort by one of the Portage developers to use experience from Portage to write an independent package manager. This, he specifies, is "not a Portage killer, but rather an independent implementation". However, in the future, his package manager may come to replace Portage. As of writing this paper in November 2006, a new version of Portage 2.0.51 is released, being simply the same code as in 2003 only with bug fixes and feature enhancements.

Although all of the Gentoo developers can agree that the package manager needs to be rewritten and replaced, after numerous attempts they give up. Why is it that they fail to rewrite and replace the package manager?

Discussion

A number of problems are raised in connection with rewriting Portage. Complex interdependencies between both modules and functions within the software makes it difficult to understand parts of the software without a complete understanding of the whole. Interdependencies also make it difficult to make changes without breaking existing functionality. Because of this, only four Gentoo developers know the source code well enough to make changes. Combined with the recurring problems of third-party applications, many of which operate directly on Portage's different data bases with their proprietary data structures, ceasing to function after changes have been made to Portage, the number of developers who can make meaningful changes to Portage limits its continued development and maintenance of Portage.

This is the situation that the Gentoo developers time and again present and draw upon for motivating and explaining the interests and interest groups for rewriting the Portage code and to justify their suggested solutions. The texture of the situation remains largely unchanged throughout the period. The problems they frame and the interests the Gentoo developers construct all emerge from this context. In this section we will look closer at how this context enables and constrain the process of rewriting and replacing Portage.

Mobilizing resources, balancing interests

Why do the repeated attempts at rewriting Portage fail? Towards the end of April 2004, the Gentoo developers describe the first attempt at rewriting Portage as "hot

air", "vaporware", and "mostly a buzzword". A predominant explanation for the repeated failures is exemplified by the following quote:

A rewrite is a MAJOR waste of extremely limited resources. Unless Gentoo gets MANY more Portage devs OR can manage without a Portage update for 6-12 months, a rewrite won't happen in any reasonable time ... In the mean time, what happens with the existing implementation? Do you [have people] work on it? Or do you let it sit idle/stagnant. The amount of time it'd take would really drag out on the developers that want new features and simplifications ... Resources are why the rewrites failed.

The issue of limited resources is the recurring explanation. The demise of both next generation Portage and Portage modularized are explained in terms of the strain on developer resources. However, given the number of Gentoo developers, the programming resources within the community are significant. It is these resources the next generation Portage developers want to tap in by turning Portage into "a community project". It is therefore not because resources themselves are scarce that the rewrite efforts fail. The problem facing those who want to rewrite Portage can be framed by Glass (1999, p.104)'s befuddlement: "I don't know who these crazy people are who want to write, read and even revise all that code without being paid anything for it at all." Similarly, based on the observation that the interests, needs, and know-how of OSS community members varies greatly, Bonaccorsi & Rossi (2003, p.1244) asks: "[h]ow is it possible to align the incentives of several different individuals"?

It is this selfsame problem the various efforts to rewrite Portage is facing: how to align the interests of the community at large in order to mobilize the resources for rewriting? In the first attempt at rewriting Portage, turning the package manager into "a true community project" goes through the four developers who will rewrite Portage with a core system and "a solid API for components [where] major parts that are now core Portage are going to be implemented as components". By framing a set of problems and actors whose interests are blocked by these problems, the four developers tries to mobilize resources (Callon 1986) for rewrite and replace Portage. These translations are summarized in Figure 2 below.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Figure 2 The Portage-ng developers' translations

However, it is not only a question of mobilizing any odd resources. The problem of the next generation Portage developers is that they want to mobilize particular resources. By translating interests into modules that clearly delineated boundaries between actors and their interests, and by inscribing these as boxes in an architecture diagram, the four developers make the architecture diagram stand in for their translations, making them more durable. Through the use of boxes, labels, and clearly separating between boxes, the architecture diagram provides an overview of dependencies between various parts of the architecture; in other words: it inscribes a sequence of work.

By saying that the programming language for realizing next generation Portage is to emerge from the requirements, they are mobilizing resources to do the requirements work first, while leaving to the small next generation Portage team to write the core system first. As such, the resources they want to mobilize are for writing the plugins. However, the effect of proposing Prolog in the design and for the prototype is that resources are spent in discussing implementation language details and problems with using Prolog. While the Prolog prototype is intended to act as a focal point for mobilizing resources for developing plugins, as it fails to materialize there is no mobilization and resources become scarce.

However, the explanation that resources is the reason why the rewrites failed has to be seen in as deeply embedded in and emerging from the context. It is worth noting that although a number of objections over the plan for the first attempt at rewriting Portage, nobody questioned the feasibility of the effort. Yet, six months down the line, the Gentoo developers argue that lacking resources is why the effort failed. What has happened?

Resources are scarce because there is a competition for resources within Gentoo, as well as the constant need to attract new developer resources. The whole Gentoo effort relies on the sustained interest of users and developers. As observed with many large OSS projects, the key process for quality assurance is users reporting failures to the developers (Feller & Fitzgerald 2002). As Mockus et al. (2004) observes: the number of people reporting software failures greatly exceeds the number of developers. The sustained interest of user is therefore important for the Gentoo community.

The mechanism for sustaining this interest lies in the continued improvement and enhancement of the software, "improvements and simplifications" as put in the above quote. What we see throughout the period is therefore that the existing Portage application continues to change. Attracting new developers is a concern for the community, as the number of unresolved failure reports is continuously growing for Gentoo. Adding functionality to Portage is also seen as a way of recruiting new developers. A concrete example is the way Bob is recruited to the community by the promise that he can implement web application support for Gentoo. However, being a member of the community involves responsibilities, and resolving failure reports is one of these responsibilities. So, recruiting new developers by adding new features to Portage is not only a way of enhancing the software, but also a way of mobilizing resources for addressing the growing number of failure reports.

When the Gentoo developer above questions how the Gentoo community can manage without a Portage update for 6 to 12 months, he is alluding to constant need for balancing between the need for technical stability for rewriting Portage on one hand, and the need for adding new functionality to attract new development resources and keep existing developers interested in the project.

Transition strategy as a processes

Whereas in Jørgensen's (2001) description of the process of rewriting the FreeBSD kernel the scope of the changes and the sequence of actions seem unproblematic, we see that rewriting and replacing Portage is a continuous process of negotiating over the scope of the changes to be made, their sequence, and which actors to be involved in the process. It is about formulating a transition strategy (Monteiro 1998) for the transition from one version of the package manager to the other.

Formulating this transition strategy is a process of continuously balancing numerous interests. On the one hand there is the interest in keeping stable the features of the software to be rewritten. On the other hand, use of the software to be rewritten continues to evolve and users have interest in the existing software to evolve accordingly. A balance must be struck between these interests. However, this balance point is continuously negotiated and renegotiated, and any attempt to rewrite the software has to remain flexible to these changes.

As much as formulating a transition strategy is about imposing stability of the entire package manager, it is a negotiation over what parts to keep stable and what to change. We see this in the focus in the attempts to rewrite Portage: going from a complete rewrite of the whole artefact, to a modularization of the existing code, to the introduction of an API on top of the existing code. It is a longitudinal process of translation spanning months, during which the identity of actors and the boundaries of what is to remain stable with Portage and what can change are continuously negotiated. The actors' margins of manoeuvre, their possibilities of making incontestable statements about the efforts to rewrite and replace, is delimited through this process of translation.

When one of the Portage developers in hindsight says that rewriting Portage from scratch "is a MAJOR waste of extremely limited resources", the statement tells us nothing about why next generation Portage failed. Nor does it tell us anything general that rewriting software from scratch requires a lot of resources. Rather, the statement bears testament of how the Gentoo developers' margins of manoeuvre is limited by the installed base. There is no longer room to state that it is possible to rewrite Portage from scratch. Again, this does not provide us with the means to make generalized statements that rewriting software artefacts from scratch is never feasible because of a continuously changing installed base.

Furthermore, what we see is that to better control the process of rewriting and replacing, the boundaries of the involved actors are limited. From encompassing the entire Gentoo developer community with the rewrite of next generation Portage, the scope of involved actors are seriously reduced in both Portage modularized and the attempts at writing an API on top of the existing code. When a Gentoo developer in hindsight explains that "waiting for the community to provide requirements ... doesn't work", the statement tells us nothing about why next generation Portage failed. Nor does it leave us any margins of manoeuvre to make generalized statements about the number of actors involved that can be involved in successfully rewriting and replacing information systems. Rather, what it does tell us is that how the inertia of the installed base limits the Gentoo developers' margins of manoeuvre in making statements about the number of involved actors in the process of rewriting and replacing software.

What we can generalize, however, is this. The formulation of a transition strategy is constituted through a continuous negotiation with the installed base. This process of negotiation is a process of balancing the interests of the involved

actors – both technical and non-technical. It is a process initiated by the construction of problems and actors with interests, but it is also a process from which new problems emerge. With new problems, existing actors change and new actors emerge. As interests "are what lie *in between* actors and their goals, thus creating the tension that will make actors select only what, in their own eyes, helps them reach these goals amongst many possibilities" (Latour 1987, pp. 109-110), new relationships between actors change. As actors and their interests change, so does that which lies in between them: the interests. As such, rather than being an end product in itself, the transition strategy is continuously formulated and reformulated through a process of continuously emergent problems, actors, and interests enables and constraints the task of rewriting and replacing Portage.

Concluding remarks

In this paper we show how a transition strategy for rewriting and replacing OSS emerges from and continuously changes in response to the installed base. There is a mutual relationship between transition strategies and the context of use and development. The way transition strategies changes the context feeds back to change the transition strategy. We show how this mutual influence changes the transition strategy along three axes: the scope of the rewrite, the sequence to replace the package manager, and the actors to be involved in the change process.

While the entire Gentoo community can agree upon the need to replace the existing system, we show how the existing system's ability to continuously meet the community's interests are greater than the perceived benefits of replacing the system. Although the introduction of an API on top of Portage redirects existing connections to Portage, the transition strategies of the Portage developers were unable to redirect new connections to the existing Portage code, like those made for web application support. We show that battling the inertia of the installed base, then, is not only about changing existing connections from the software being replaced towards its replacement (Hanseth and Monteiro 2002). It is also about the ability to redirect new connections to the installed base to the replacement software throughout the process of rewriting and replacement.

In order to understand and analyse processes of rewriting and replacement, it is therefore important to understand the rationalities and logics in play by different actors. It is important not only to take the actors' own explanations of the world for real, but also to understand the logic and rationality of their explanations in the eyes of the other actors without giving any undue privilege to either view. Furthermore, statements of the world need to be contextualized, when were they made and in response to what, in order for the information systems researcher not to be locked into single actors' views as true and thereby seeing other actors' views as false. As information systems researchers it is also important not to lock on to

and give priority to some actors' techno-economic rationalities, but rather to remain sensitive to our own academic techno-economic bias and challenge this through careful analysis of the statements made by those we study.

References

- Bass, L., Clements, P., and Kazman, R. (2003). *Software Architecture in Practice*, Addison-Wesley, Boston, Massachusetts.
- Bianchi, A., Caivano, D., Marengo, V., and Visaggio, G. (2003). Iterative reengineering of legacy systems. *IEEE Transactions on Software Engineering*, 29(3), 225- 241.
- Bonaccorsi, A. and Rossi, C. (2003). Why open source software can succeed. *Research Policy*, 32(7), 1243-1258.
- Callon, M. (1986). Some elements of a sociology of translation: Domestication of the scallops and fishermen of St. Briec Bay. In *The Science Study Reader* (Biagioli, M. Ed.), Routledge, New York, New York.
- Crowston, K. and Howison, J. (2005). The social structure of free and open source software development. *First Monday* 10(2).
- DistroWatch (2006). The top ten distributions: A beginners' guide to choosing a (Linux) distribution, <http://distrowatch.com/dwres.php?resource=major>. Last visited: November 25 2006.
- Feller, J. and Fitzgerald, B. (2002). *Understanding Open Source Software Development*. Addison-Wesley, London.
- German, D. (2005). Software engineering practices in the GNOME project. In *Perspectives on Free and Open Source Software* (Feller, J., Fitzgerald, B., Hissam, S.A., and Lakhani, K.R. Eds.), p. 211, The MIT Press, Cambridge, Massachusetts.
- Glass, R. (1999). Of Open Source, Linux and Hype. *IEEE Software*, 16(1), 126-128.
- Hanseth, O. and Monteiro, E. (1998). *Understanding Information Infrastructures*. Unpublished manuscript, available at <http://heim.ifi.uio.no/~oleha/Publications/bok.html>.
- Jørgensen, N. (2001). Putting it all in the trunk: Incremental software development in the FreeBSD open source project. *Information Systems Journal*, 11(4), 321-336.
- Klein, H.K. and Myers, M.D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 23(1), 67-93.
- Latour, B. (1987). *Science in Action*. Harvard University Press, Cambridge, Massachusetts.
- Mockus, A., Fielding, R.T., and Herbselb, J.D. (2002). Two case studies of open source software development: Apache and Mozilla. *Transaction son Software Engineering and Methodology*, 11(3), 309-346.
- Monteiro, E. (1998). Scaling information infrastructure: The case of the next generation IP in Internet. *The Information Society* . 14(3), 229-245.
- Paulson, J.W., Succi, G, and Eberlein, A. (2004). An empirical study of open-source and closed-source software products. *IEEE Transactions on Software Engineering*, 30(4), 246-256.
- Samoladas, I, Stamelos, I, Angelis, L., and Oikonomou, A. (2004). Open source software development should strive for event greater code maintainability, *Communications of the ACM*, 47(10), 83-87.
- Østerlie, T. and Wang, A.I. (2006). Establishing maintainability in systems integration: Ambiguity, negotiation, and infrastructure. In *Proceedings of the 22nd International Conference on Software Maintenance*, 24-26 September 2006, Philadelphia, Pennsylvania,

Migration to Open Source Office Suite

Martti Karjalainen

Ministry of Justice, Finland

martti.karjalainen@om.fi

Abstract. Open source software and open standards are becoming increasingly important as organizations seek to improve the interoperability and decrease the overall IT expenditures. Several case studies have been reported addressing the migration to open source server software, but reports covering large-scale desktop migrations are rare. This report presents a case study involving the largest transition in Finland to an open source office suite and to an open office document standard. The case study fills a knowledge gap between the availability of open source office suite software and the actual deployment of the office software in case of a large user organization in Finland. The Finnish Ministry of Justice and its administrative sector is migrating to the open source OpenOffice.org office suite and adopting the OpenDocument ISO standard ISO/IEC 26300 for the file format of office documents. The migration involves close to 10 000 persons and more than 10 000 workstations. The migration was based on office software evaluation in 2005 and an extensive OpenOffice.org pilot project in 2006. The main results of the office software study are presented in the paper including the various migration options and their cost estimates. The functionality and compatibility of OpenOffice.org were tested extensively in the pilot project. The evaluation of training and support requirements, workstation installations and configurations were also among the tasks of the pilot project. The results of the pilot project are presented in the paper. Various measures and tools have been applied in order to support a successful migration. Supportive measures are discussed and information on the current status of the OpenOffice.org migration is given.

Keywords. Migration, Open source, Office suite, OpenOffice.org, OpenDocument.

I. Introduction

The low licensing costs of open source software combined with the increase of the costs of proprietary software has attracted organizations with the promise of a decrease in the overall IT expenditures. As noted by Russo et al. (2005a), several case studies have been reported addressing the adoption of open source server software. Famous examples of popular open source server software solutions are the Linux operating system, the Apache web server, and the Sendmail e-mail software which hold worldwide large market shares in server software. Open source server software is used as an infrastructure platform which is for the most part invisible to the user. The invisibility allows a technical approach to the software adoption without the need to pay special attention e.g. to personnel training and user acceptance issues.

In spite of the success in the server software, reports covering large-scale open source desktop adoptions are rare. Desktop Linux in large organizations is still not common. The same applies to the OpenOffice.org office suite which covers major personnel productivity applications like text processing, spreadsheets and presentations. Unlike server software, the desktop software is highly visible to the user. This complicates the migration issue. In addition to licence fees and technical integration, there is a wide variety of influencing factors to consider starting from user acceptance, personnel training, and even personnel application integrations.

Fitzgerald (2006) has pointed out the knowledge gap that exists regarding open source adoption to satisfy business needs. Numerous open source products are currently available but the lack of vendors to provide marketing information cause a large knowledge gap. According to Fitzgerald, an up-to-date catalog of high-quality open source products is needed which could provide details on the functionality offered by various products, the types of support available, training needs, reference sites of deployment, and companies offering support. The same concern was expressed by Russo et al. (2005b) by stating that information on the empirical view of open source migrations with the aid of case studies is missing.

This report presents a case study involving the largest transition in Finland to an open source office suite and to an open office document standard. Reports covering large-scale open source desktop adoptions are rare, and this report fills thus an important gap in the knowledge base of open source migrations. The transition involves close to 10 000 persons and more than 10 000 workstations. The publicly known open source office suite migrations in Finland have this far been in organizations involving at most a couple of hundred users.

The issue of office document standards is also involved in this case study. In public administration, electronic documents are a central tool both in the editing and archiving contexts. Editing includes both the drafting of the documents, the subsequent modifications and the passing on of documents to other users and

organizations. Archived documents are no longer produced, but merely reproduced by displaying or printing. The document exchange format is extremely important to public administrations. Currently the vast majority of organizations use proprietary office suite software like Microsoft Office and correspondingly proprietary document file formats. These document formats are closed, i.e. are not fully or not regularly published and are exclusively controlled by the software manufacturer. Proprietary document formats hinder the interoperability of document exchange. In practical terms, it often makes sense to pass documents on to partners who use the same software only. Manufacturer-specific formats thus pose difficulties when it comes to communicating with citizens and other organizations.

The market for office document formats has recently been active. It is obvious that the transition from closed proprietary formats to more open file formats is evident. The OpenDocument (ODF) file format was first published as an OASIS standard (OASIS, 1 May 2005) and then accepted as an international ISO standard ISO/IEC 26300 (ISO, 8 May 2006). Several office productivity programs are already supporting the OpenDocument format, including the open source OpenOffice.org office suite. Office Open XML (OOXML) is the new file format introduced by the Microsoft Office 2007 suite. It has been standardized by Ecma International as Ecma 376 (ECMA, 7 December 2006) and ISO standardization is currently in progress.

The case study of this report includes both the migration to an open source office suite and to the OpenDocument file format for office documents. In December 2006, the Finnish Ministry of Justice decided to migrate to the open source OpenOffice.org office suite. The decision also included the adoption of the OpenDocument ISO standard for the file format of office documents.

The office suite platform of the ministry was based on Windows workstations with IBM Lotus SmartSuite on 7000 desktops and Microsoft Office on 3000 desktops. After the migration, OpenOffice.org will be the primary office suite for 8500 persons and Microsoft Office for 1500 persons. All Windows XP workstations of the ministry and its administrative sector are installed with OpenOffice.org version 2.

The migration decision was based on office software evaluation in 2005 and an extensive OpenOffice.org pilot project in 2006. The main results of the office software study are presented in Section II. The functionality and compatibility of OpenOffice.org was tested in daily office use in the pilot project. The evaluation of training and support requirements, workstation installations and configurations were also among the tasks of the pilot project. The results of the pilot project are presented in Section III. The migration process started in the beginning of 2007. Various measures and tools have been applied in order to support a successful migration. These supportive measures are discussed and information on the current status of the OpenOffice.org migration is given in Section IV.

II. Office software evaluation

The office software evaluation report was published by the Ministry of Justice in 2005 (Karjalainen, 11 March 2005). The report includes several recommendations, e.g. an extensive migration to OpenOffice.org and the adoption of XML based OpenDocument file format for office documents.

The main focus of the evaluation was office software for word processing, spreadsheet and presentations. Various software products used within the ministry and its administrative sector in 2005 are shown in Table 1.

Office software	Version(s)	Licenses
Lotus SmartSuite (WordPro, 1-2-3, Freelance Graphics)	SmartSuite 97, SmartSuite Millennium	7200
Microsoft Office (Word, Excel, PowerPoint)	Office 97, Office 2000, Office XP, Office 2003	2900
WordPerfect	5.1	< 300

Table 1. Office software usage in 2005

Office software was used on the Windows NT 4 platform. The yearly software license maintenance cost was 297 000 €. Various license purchase options had been used during past years, and a large number of the software licenses were not covered by license maintenance contracts.

It is obvious that the office software situation had numerous problems. Altogether seven office products, including the office software packages and their different versions, were being used. Old program versions created compatibility problems both internally and externally with other organizations and citizens.

Various application integrations to office software had been developed during the years. The most important integrations analyzed in the software evaluation report were the following:

- Several court information systems have built-in integration to SmartSuite WordPro. Applications are based on IBM Notes/Domino platform and have modules written in the LotusScript language for the integration of Notes/Domino forms to WordPro.
- The civil case management system in district courts uses WordPro for document processing. The application runs on Linux platform, has BEA Tuxedo/Jolt middleware and uses Java modules, XML technology and

WordPro macros in the integration of document processing and the application data base.

- The prison information system uses Word and Excel for document print-outs. The application runs on Windows Server platform, is based on Visual Basic programming and Active-X technology in the integration of Word and Excel document templates to the application data base.
- All ministries in Finland share common applications of the Finnish Government. These applications are used to prepare documents for the cabinet and also for the context of the European Union. The applications are based on Microsoft technology using VBA macros and binary Word and Excel file formats.

The following three migration options were evaluated in the study:

Lotus SmartSuite option	Microsoft Office option	OpenOffice.org option
Migration to SmartSuite Millennium on 7000 workstations and to Microsoft Office 2003 on 3000 workstations	Full migration to Microsoft Office 2003 on 10 000 workstations	Migration to OpenOffice.org on 8500 workstations and to Microsoft Office 2003 on 1500 workstations

Table 2. Migration options

The Lotus SmartSuite option can be characterized as a "do as little as possible" option. New software versions are introduced, but otherwise changes are minimal. The requirements for user training, document conversions and application integration modifications are low in this option. The risks involved with the future of Lotus SmartSuite remain unchanged in this option. The product is not being developed actively any more which suggests evident compatibility problems for the coming years.

The Microsoft Office option involves a complete migration to Microsoft Office 2003. The same software version is introduced for all users. This option requires user training, document conversions and modifications to application integrations. The risks involved with Lotus SmartSuite are eliminated. Only minor compatibility problems can be expected when using the market leader in office suite software.

A partial migration to OpenOffice.org is introduced in the third option. The Lotus SmartSuite office suite is completely replaced by OpenOffice.org. Also half of the of Microsoft Office licenses are replaced by OpenOffice.org. A complete

migration to OpenOffice.org was not considered a practical option e.g. due to the Microsoft technology based application integrations in the document handling of the Finnish Government. The OpenOffice.org option involves highest requirements for user training, document conversions and modifications to application integrations. The generous licensing terms of OpenOffice.org are a cost benefit but also the benefits of an open XML based document format are an important factor in favor of the OpenOffice.org option. The EU recommendations for public administrations were published in 2004 and they were favorable for open XML based file formats for interoperability and long-term access of documents (IDA, 1 June 2004). The XML file format used by OpenOffice.org had been forwarded for standardization in OASIS and it was obvious that it would become an international standard. Several compatibility and migration evaluations had been published, see e.g. (Poulsen et al., 2002), (Vestin, 2003), (CNIPA, 15 September 2004), (OGC, 28 October 2004), (IDA, 4 November 2004), and (IDABC, 17 January 2005). The evaluations suggested that only minor compatibility issues would be expected in the OpenOffice.org option.

For the cost evaluation purposes, a 6-year period 2006-2011 was chosen. The migration from Windows NT 4 platform to Windows XP was planned for the year 2006. The year 2011 is the last year for the extended support of the Windows XP operating system. For all migration options, the following cost factors were included in the cost evaluation:

- license purchases
- license maintenance
- training and support
- document conversions and modifications to application integrations

Table 3 gives a summary of costs for the years 2006-2011.

	Lotus SmartSuite option	Microsoft Office option	OpenOffice.org option
License purchases	423 000 €	3 315 500 €	349 000 €
License maintenance	1 874 000 €	5 186 000 €	2 004 500 €
Training and support	500 000 €	880 000 €	1 155 000 €
Document conversions, application integrations	75 000 €	445 000 €	685 000 €
Costs total	2 872 000 €	9 826 500 €	4 193 500 €

Table 3. The costs of the migration options 2006-2011

All costs given in Table 3 include some Microsoft Office license purchase and maintenance costs. In all options there are also costs related to Lotus SmartSuite licenses. The licensing bundle of Lotus SmartSuite and Lotus Notes clients creates some extra costs for each migration option. An explanation for the low costs of the Lotus SmartSuite option comes from the fact that in this option no change in the current license maintenance agreements would be introduced, and so a large portion of licenses would not have yearly license maintenance costs.

The cost evaluation does not follow a full TCO (total cost of ownership) model as described e.g. by Russo et al. (2005a). The categories structuring a TCO calculation are strongly driven by the context. In this case the old Lotus SmartSuite platform brings some unique considerations. For all migration options, hardware costs are considered equal and are excluded from the cost calculation. The cost evaluation period 2006-2011 reflects the software deployment time on Windows XP platform and not the exact migration time. However, main TCO categories like software, training and support costs are included.

The key recommendations of the office software evaluation are summarized in Table 4.

-
- The Ministry of Justice and its administrative sector migrates to the open source OpenOffice.org office suite for 8500 persons and to Microsoft Office 2003 for 1500 persons.
 - The XML based OpenDocument file format is adopted as the file format for office documents.
 - OpenOffice.org is installed on all Windows XP workstations.
 - The migration is scheduled to commence from the beginning of 2007 when the migration from Windows NT 4 platform to Windows XP platform has been completed.
 - The final migration decision should be reached by October 2005.
-

Table 4. The recommendations of the office software evaluation

III. OpenOffice.org pilot project

The office software study was continued by launching a pilot project based on the new OpenOffice.org version 2. The original plan was to start piloting in summer 2005 but the delay in the availability on version 2 postponed the pilot project by several months. OpenOffice.org version 2 became available in October 2005. Due to the delay, also the the final migration decision was postponed until the results of the pilot project would be available.

The piloting lasted from 1 December 2005 to 30 September 2006. The participants included over 150 persons from four offices in the administrative sector mainly in the Hämeenlinna region in Southern Finland. All participants had previous experience in the use of office suite software (either Microsoft Office or Lotus SmartSuite or both). The offices represent the largest office software user sectors in the administrative sector. The pilot offices were the District Court, the District Prosecutor's Office, Legal Register Centre, and ICT Service Centre.

The technical environment of the pilot was the ordinary Windows XP and Windows NT 4 workstation platform of the pilot offices. Piloting used OpenOffice.org version 2 which supports the OpenDocument standard as its default file format. In addition to OpenOffice.org, also Lotus SmartSuite Millennium and Microsoft Office 2003 software packages were used in the pilot project.

The main two tasks of the pilot project were to test the *functionality* of OpenOffice.org for the tasks of the administrative sector and the *compatibility* of OpenOffice.org with Lotus SmartSuite and Microsoft Office software. Other tasks included the evaluation of requirements for user support and training. Also specifications for workstation installation and configuration on the Windows XP platform were to be produced during the pilot project.

All tasks described above were completed in the project. A detailed description of the project and its results is given by Karjalainen (12 October 2006).

Functionality

The key results of the piloting, the functionality and compatibility of OpenOffice.org, were published in a separate report (Karjalainen, 18 May 2006). The report presents the functionality and compatibility in the form of 87 questions and answers. These questions represent one-to-one all user questions during training and piloting. The source of questions were all user contacts to help desk service and to IT support personnel. Also discussions during training events were an important source for questions. The questions presented by users are given here in Appendix and they can be categorized as follows:

- general topics (18 questions)
- text processing (31 questions)
- spreadsheets (31 questions)
- slide presentations (15 questions)

Questions are on different levels of complexity. There are questions on small details like how to make a hanging indent as specified the official Finnish document standard. On the other hand, some questions cover wide topics and require more comprehensive explanations like the management of spelling and hyphenation in foreign languages.

Concerning functionality, the questions and answers explore comprehensively the topics of document production in the administrative sector. The functionality of OpenOffice.org covered the needs in document processing from basic functions to more developed automation functions (like paragraph and page styles, document templates and abbreviation handling). Also the requirements in multilanguage document production were met by OpenOffice.org (user interfaces in several languages, spelling and hyphenation in several languages).

The support of different file formats is, as a whole, one of the strong points of OpenOffice.org. The software opens and saves file formats used by a large number of programs. A good example is the ease of producing PDF files.

In order to further support file format management, the OpenOffice.org piloting platform included *MultiSave* which is a free add-on module to OpenOffice.org. The pilot project developed the original French version of MultiSave further by creating a multi-language version and adopting it to the Finnish language. With MultiSave a document can easily be saved in altogether three formats in different files in one save operation. The formats supported by MultiSave are the three most common formats used: OpenDocument, Word/Excel/PowerPoint and PDF.

Another example of the additional functionality is *OpenOffice.org Portable*. It can be installed on a USB memory stick and it can be used in any Windows computer supporting the USB interface. The memory stick has a complete OpenOffice.org installation. With OpenOffice.org Portable, OpenDocument and Microsoft Office documents can be handled in any Windows desktop without workstation installation.

The general conclusion concerning the functionality of OpenOffice.org can be given as follows.

The functionality of OpenOffice.org covers the needs of the administrative sector of the Ministry of Justice. In ordinary tasks, only a small part of the features of the software are utilised.

Compatibility

The compatibility is a more complicated issue than functionality. A large portion of the OpenOffice.org handbook (Karjalainen, 18 May 2006) is devoted to compatibility issues. OpenOffice.org natively supports the OpenDocument file format which was first published as an OASIS standard (OASIS, 1 May 2005) and then accepted as an international ISO standard ISO/IEC 26300 (ISO, 8 May 2006). Both Lotus SmartSuite and Microsoft Office are based on proprietary file formats. The handbook gives detailed guidelines for the management of file formats used by Lotus SmartSuite and Microsoft Office.

The compatibility of OpenOffice.org with different Microsoft Office versions, including Office 2003, is high. OpenOffice.org is able to open and save Word, Excel and PowerPoint files automatically. During the pilot project, all Word, Excel and PowerPoint files could be opened and processed with OpenOffice.org. However, documents containing VBA macros are not fully compatible requiring a separate conversion. In ordinary documents VBA macros are rare. With some documents, minor fidelity issues with text layout could also be noticed.

Where necessary, OpenOffice.org can be specified as the default application for Word, Excel and PowerPoint files. For migration purposes, OpenOffice.org includes a wizard function (*Document Converter*) for the conversion of Word, Excel and PowerPoint files to OpenDocument format. The MultiSave add-on module enables saving a document simultaneously both in Microsoft Office format and in OpenDocument format.

The compatibility of OpenOffice.org with Lotus SmartSuite is not as high as with Microsoft Office. Lotus 1-2-3 spreadsheet files can be opened directly but word processing files (WordPro) and slide presentations (Freelance Graphics) have to be saved or converted separately to a file format supported by OpenOffice.org. WordPro files can e.g. be saved in Microsoft Word format and Freelance Graphics files in PowerPoint format which can then be opened by OpenOffice.org.

The general compatibility conclusions can be summarized as follows.

The compatibility of OpenOffice.org with the different Microsoft Office versions, including Office 2003, is high. OpenOffice.org is able to open and save Word, Excel and PowerPoint files automatically. Where necessary, OpenOffice.org can also be specified as the default application for Word, Excel and PowerPoint files.

The compatibility between OpenOffice.org and Lotus SmartSuite is partly automatic. The compatibility requires that users know which file formats are supported by both software packages.

Training

Altogether 18 OpenOffice.org training events were arranged for a total of 164 participants during the piloting. Each event lasted one day for a maximum group size of 15 persons. The majority of the events (16) were basic OpenOffice.org training events. In two training events the focus was on document templates and forms. Teachers from outside training service providers were used for most of the courses. Also in-house training given by own IT staff members was arranged.

The framework shown in Table 5 below was developed for the contents and structure of a basic OpenOffice.org training day. In addition to main functions in

text processing, spreadsheets and slide presentations, the emphasis of the training is in file management and compatibility issues.

OpenOffice.org training day - goals

- Understanding overall functionality of OpenOffice.org
- Basic skills in the use of OpenOffice.org

Previous knowledge

- Experience in the use of some office suite software

General topics

- Network learning environment for OpenOffice.org (Moodle)
- What is OpenOffice.org?
- File formats: OpenDocument, XML, PDF, doc/xls/ppt
- Installation procedure of OpenOffice.org
 - Path settings for own documents and templates

Text processing - Writer

- The Writer interface: Title bar, Menu bar, Standard toolbar, Formatting toolbar, Status bar
- File management: open/save, OpenDocument, PDF, doc-files, lwp-files, MultiSave
- Inserting and modifying text, copy/paste, copy/paste special
- Practising
- Styles and formatting, paragraph styles: Default, Body text
- Heading styles: Heading 1, Heading 2, Heading 3
- Page styles: Default, First page
- Spelling and hyphenation
- Document templates
- Tab stops, indents, bullets and numbering, tables, pictures
- Practising

Spreadsheets - Calc

- The Calc interface: Title bar, Menu bar, Standard toolbar, Formatting toolbar, Formula bar, Status bar
- File management: open/save, OpenDocument, PDF, xls-files, 123-files, MultiSave
- Cell references, series, AutoFill
- Functions and formulas, sum function
- Inserting a chart
- Page and cell area formatting
- Borders, background, print scale adjustment
- Practising

Slide presentations - Impress

- The Impress interface: Title bar, Menu bar, Standard toolbar, Line and Filling toolbar, Drawing toolbar, Status bar
- File management: open/save, OpenDocument, PDF, ppt-files, MultiSave
- Adding and modifying slides, using slide designs
- Master slides
- Slide transition effects
- Practising

Questions and answers

Table 5. Basic OpenOffice.org training day

Several Finnish and English manuals were used in the training. The manuals in Finnish were produced in connection with the piloting. The English-language manuals were taken from the web site of the OpenOffice.org documentation project¹. The following manuals were used at the different stages:

- OpenOffice.org Express Guide (in Finnish)
- OpenOffice.org Template Guide (in Finnish)
- OpenOffice.org Handbook of Questions and Answers (in Finnish)
- Getting Started (introductory guide in English)
- Writer Guide (text processing guide in English)
- Migration Guide (in English)

The piloting and training experiences inspired to prepare a general-purpose OpenOffice.org handbook (Karjalainen K. and Karjalainen M., 23 October 2006). The handbook is the most comprehensive handbook of OpenOffice.org in Finnish and it is freely available to all.

A browser-based OpenOffice.org learning environment was established in the Internet to support training and piloting. The learning environment is based on the open source Moodle software and it contains e.g. frequently asked questions, handbooks, training materials as well as discussion and problem solving pages.

On the basis of the piloting results, the starting point to OpenOffice.org training can be summarized as follows:

The basic skills to use OpenOffice.org are adopted in a one-day training.

OpenOffice.org training materials in Finnish are available as the result of the pilot project.

¹ <http://documentation.openoffice.org/>

Support services

The actual need for daily user support is influenced by training and the availability of handbooks and various additional tools. The user support arrangements during the pilot project is summarized in Table 6.

– Basic training day for each person
– Additional training day on document templates for selected persons
– Handbooks (both in Finnish and in English)
– Browser-based OpenOffice.org learning environment
– Document templates complying with the Finnish document standard SFS 2487
– Support service agreement with an external service provider

Table 6. User support arrangements in the pilot project

The IT service organization of the Ministry of Justice employs 130 persons and includes e.g. technical support and Help Desk. To strengthen the OpenOffice.org user support during the piloting, an agreement with an external service provider was made.

Past experience with office suite software has shown that almost all user support tasks can be solved by the own IT staff members of the ministry. The Lotus SmartSuite and Microsoft Office software packages have been in use for almost ten years, and the number of problem contacts to IBM and Microsoft software support have been very rare. The same was experienced in the pilot project: there were only two problem contacts to the outside service provider (and even these two could have been solved by the own IT staff). The detailed list of all user questions presented during the pilot project is given in Appendix.

Considering technical support, several OpenOffice.org versions were installed and updated during the pilot project. Both standard installations from the installation CD-ROM and silent installations based on systems management software were used. The documentation of OpenOffice.org proved to be sufficient for the management of installations. External expert advice was used twice during the pilot project: once in order to have a second opinion on the recommended user settings of OpenOffice.org (the various options in the *Tools* menu) and once in the modification of the *setup.xcu* file in order to customize the default text template setting.

The conclusions of support service evaluation can be summarized as follows:

There is no need for an external Help Desk agreement with an external service provider for OpenOffice.org user support. The need for support appears seldom and expert services should be acquired on a case-by-case basis.

The installations of OpenOffice.org software versions can be done as internal work. External technical support services should be acquired on a case-by-case basis.

Installations and configurations

During the piloting, installation packages were prepared for OpenOffice.org versions 2.0.0, 2.0.1, 2.0.2 and 2.0.3. For the installation of OpenOffice.org on Windows XP platform for all 10 000 workstations of the Ministry of Justice and its administrative sector, a special installation model based on OpenOffice version 2.0.2 was prepared. The installation model was published as a general-purpose handbook giving guidelines in several installation issues (Friman and Karjalainen, 12 September 2006). It was written to serve both private persons and organizations considering the migration to OpenOffice.org. The installation model consists of the entities shown in Table 7 below.

-
- Basic installation of the Finnish-language OpenOffice.org
 - Recommendations on OpenOffice.org user settings
 - Installation of the Swedish language package to enable the Swedish user interface
 - Installation of the Finnish spelling and hyphenation package
 - Installation of spelling and hyphenation packages for foreign languages
 - The design and installation of a customized default text template
 - Installation of MultiSave add-on module
 - Installation of the clip art library
 - OpenOffice.org settings for Swedish-language offices
-

Table 7. The OpenOffice.org installation model on Windows XP platform

Most of the pilot project participants completed the OpenOffice.org installation on their workstations by themselves. Expert help was available, but practical experience in the installation was considered helpful in order to e.g. encourage persons to do installations also on their home computers. Also a CD-ROM for home computer installations was made available.

Other aspects

The pilot project aimed at maximum transparency so that the results could easily be used also by outsiders. Plenty of material was published in the Internet freely available for all interested parties. In addition to several handbooks and the MultiSave module, also document templates complying with the Finnish SFS standard 2487 were made available.

Some miscellaneous observations during the pilot project can also be reported:

No *information security* problems related to the OpenOffice.org software or the OpenDocument format appeared during the piloting.

The *resistance to office suite change* during the piloting was minor than expected. OpenOffice.org and the open source software were generally experienced as positive and interesting issues.

IV. Migration

The final migration decision was originally expected in 2005. Delays in the availability of OpenOffice.org version 2 postponed the decision till 2006.

Revised cost estimates

The costs for the three migration options in Table 3 were estimated in 2005. Since then, important changes in the cost factors had occurred. A revised cost estimate was produced to reflect the new situation. The revised cost estimates for the migration options are given in Table 8.

	Lotus SmartSuite option	Microsoft Office option	OpenOffice.org option
License purchases	668 300 €	2 517 000 €	211 000 €
License maintenance	737 000 €	3 545 000 €	737 000 €
Training and support	200 000 €	370 000 €	580 000 €
Document conversions, application integrations	105 000 €	355 000 €	535 000 €
Costs total	1 710 300 €	6 787 000 €	2 063 000 €

Table 8. The revised costs of the migration options 2006-2011

The costs of all migration options in Table 8 are considerably lower than the costs in Table 3. During 2005-2006, the licensing bundle of Lotus Notes client software and Lotus SmartSuite was dissolved. This helped to exclude all costs related to Notes clients from the calculation. For Lotus SmartSuite, a one-time license charge was negotiated for the Windows XP platform to enable opening of old SmartSuite files. The costs of Microsoft Office licenses were reduced when the number of Office Professional licenses was adjusted to follow the licensing decisions made during 2006. The positive results of the pilot project allowed some reduction in the training and support costs.

The migration decision

The results of the pilot project were positive for the OpenOffice.org migration. The functionality of the software covered the needs of the ministry and its administrative sector. The compatibility of OpenOffice.org with other software packages was high. The need for external support services is low, and the pilot project had produced training materials and various support tools for the migration.

The cost evaluation showed that the costs in the OpenOffice.org option and in the Lotus SmartSuite option are considerably lower than in the Microsoft Office option.

The native support of the OpenDocument ISO standard is an important factor concerning the interoperability and long-term access of documents.

The influence of OpenOffice.org to personnel productivity in document handling was not explicitly measured in the pilot project. Practical experience showed that no obvious differences in document handling times could be noticed when compared to Lotus SmartSuite or Microsoft Office. Recent studies suggest that personnel productivity is not influenced negatively when a migration to OpenOffice.org is done. The Danish Ministry of Science, Technology and Innovation conducted an experiment with six public organizations using Microsoft Office and OpenOffice.org as the targets for office software migration. The results showed that there was no visible economic effect (neither influence in the use of resources nor in productivity) in the workflows, no matter which office suite was chosen (Devoteam, 11 May 2005). The only difference in the total costs (direct as well as indirect) was related to license fees. Also other studies had given similar productivity results, see Russo et al. (2005b, 2005c). In these studies personnel productivity was not affected by the introduction of OpenOffice.org software. The number of documents handled daily had not reduced nor had the the global effort to handle documents increased.

The final migration decision was made on 1 December 2006 by the Permanent Secretary and the CIO of the Ministry of Justice:

The Ministry of Justice has decided to migrate to the open source OpenOffice.org office suite. OpenOffice.org will replace the Lotus SmartSuite software, and also part of Microsoft Office software packages will be replaced by OpenOffice.org. After the migration, 85 % of the total document processing will be handled by OpenOffice.org and 15 % by Microsoft Office.

The migration is scheduled to commence from the beginning of 2007.

The Ministry of Justice and its administrative sector will adopt the OpenDocument ISO standard for the file format of office documents.

The status of migration

The migration to OpenOffice.org and OpenDocument was scheduled to commence from the beginning of 2007. However, important preliminary actions had already been completed during 2006:

- (1) OpenOffice.org installation was included in all workstations during the migration to Windows XP platform.
- (2) Several Finnish-language handbooks were made available as the result of the OpenOffice.org pilot project:
 - OpenOffice.org Handbook of Questions and Answers
 - OpenOffice.org Express Guide
 - OpenOffice.org Template Guide
 - OpenOffice.org Installation Handbook
- (3) The MultiSave add-on module was made available for easy management of file formats.
- (4) The pilot project had produced a browser-based OpenOffice.org learning environment which contains e.g. frequently asked questions, handbooks, training materials as well as discussion and problem solving pages.
- (5) Document templates complying with the Finnish document standard SFS 2487 were produced as the result of the piloting.
- (6) A tested framework for the contents and structure of a basic training was available.
- (7) An installation CD-ROM with instructions and handbooks, suitable also for home computer installations, was available. Also the USB memory stick version, OpenOffice.org Portable, was available.

The transition to OpenOffice.org and OpenDocument by the Finnish Ministry of Justice shares several factors with the initiative of the French public

administration. According to IDABC news (IDABC, 7 July 2006), France's newly formed Directorate General for the Modernisation of the State prepared during 2006 an extensive set of tools for French administrations to assist them in their migration to OpenOffice.org: a CD-ROM for the installation of OpenOffice.org, a training pack, on-line training assistance, a communications pack, various support tools, guidelines, etc. Basically the same set of tools was produced in the OpenOffice.org pilot project of the Ministry of Justice.

Altogether seven office products were used before the migration (see Table 1). On the Windows XP platform, the number of office products has been reduced to four. In addition to OpenOffice.org version 2, both Microsoft Office 2003 and Office 2000 are used for certain tasks. For Lotus SmartSuite, a one-time license charge was negotiated for the Windows XP platform in order to enable opening of old SmartSuite documents. The migration approach taken by the Ministry of Justice follows a step-by-step process where existing integrations with office software and applications are gradually modified allowing old office software to be phased out.

From the 10 000 persons employed by the ministry and its administrative sector, more than half can be migrated to OpenOffice.org in a short period of time. Others have various restrictions implied by application integrations.

The migration was started with an information campaign where all IT staff members and all IT contact persons in 300 offices were informed on the OpenOffice.org migration. Introductory information on the use of OpenOffice.org on the Windows XP platform was made widely available. The installation CD-ROM and the OpenOffice.org handbook (Karjalainen K. and Karjalainen M., 23 October 2006) has been distributed throughout the organization. The campaign has provided enough guidance for employees to handle e.g. OpenDocument files received as e-mail attachments. In a large organization of 10 000 employees there are hundreds of skilled users who are able and willing to use new software immediately when it is available.

In addition to basic training, the migration needs to address issues related to the conversion of old documents and to the introduction of OpenOffice.org document templates.

The initial migration focus has been on the largest offices situated in Helsinki, Espoo, Vantaa, Tampere, Turku, and Oulu. These offices employ over 2000 persons. In addition, migration was started in the offices in Hämeenlinna region which employ 200 persons. In-house OpenOffice.org training has been arranged for IT staff members in order to provide them with skills needed in the OpenOffice.org support. Basic one-day training following the framework developed in the pilot project has been given for the employees. Also short 2-hour training events for larger groups have been arranged. In these short events, the focus has been on the network learning environment, basic text processing functions and document interoperability issues.

The basic training has been supplemented by document template workshops for selected users. The OpenOffice.org templates following the Finnish document standards are the basis of the workshops. The standard templates are supplemented with the required details of specific offices. The templates include e.g. various letter, memorandum and facsimile templates in several languages. Also customized slide presentation templates for offices have been provided. Altogether over 1000 document templates have been produced this far.

The migration phase does not involve massive document conversions. Microsoft Office documents do not need conversion, they can be opened and processed directly by OpenOffice.org. Also Lotus 1-2-3 spreadsheets can directly be processed by OpenOffice.org. In order to support migration from Lotus WordPro to OpenOffice.org Writer, WordPro installation is available. Old documents can be opened by WordPro and document contents can be transferred to Writer either using copy/paste or saving the document e.g. to MS 2000 Word format.

The training of in-house trainers is of key importance to successful migration. This far no outside service providers have been used in the migration or in the support service arrangements. The development of in-house knowledge and OpenOffice.org support skills is considered to be vital to the successful migration.

Negative experiences in the migration have been rare. The positive results of the OpenOffice.org pilot project have been valid in the actual migration. Also the resistance to the change in office software has been rare. The positive attitude and user acceptance can be strengthened by focusing in training, standards complying document templates, good handbooks and supportive tools. The strong points like the support for standards and document interoperability in addition to the free installation possibilities of OpenOffice.org are emphasized in the introduction of the software to new users.

The Ministry of Justice is an important customer to several Finnish IT companies. The companies produce large amounts of IT systems documentation as part of their services. The migration to OpenDocument file format in systems documentation has also started.

V. Discussion and conclusions

This report presented a case study involving the largest transition in Finland to an open source office suite and to an open office document standard. Reports covering large-scale open source desktop adoptions are rare, and this study fills an important gap in the existing literature and thus in the knowledge base of open source migrations. The reported transition involves close to 10 000 persons and more than 10 000 workstations. The publicly known open source office suite migrations in Finland have this far been in organizations involving at most a

couple of hundred users. According to the June 2007 market share information², the migration of the Finnish Ministry of Justice is also the largest open source OpenOffice.org based migration in Scandinavia. Several large OpenOffice.org migrations have been reported in the French government administrations, including French customs, French Ministry of Interior, and Gendarmerie National.

The initial and revised cost evaluations of the study showed that important cost savings can be realized with the open source migration. When compared with the proprietary Microsoft Office option, the cost savings were close to 5 M€ or 70% during the 6 year evaluation period 2006-2011. Considering the generalization of the cost evaluation, it should be noted that migration details and actual migration costs are strongly dependent on the environment. The results cannot be directly generalized to other large organizations. However, it is safe to expect that there are also other large organizations where the migration to open source office suite would be equally justified.

An extensive pilot project was carried out and its results were encouraging for the open source migration. The functionality and compatibility of OpenOffice.org were tested extensively. The functionality of OpenOffice.org covered the needs of the administrative sector of the Ministry of Justice. In ordinary tasks, only a small part of the features of the software are utilized. The compatibility with Microsoft Office versions is high. OpenOffice.org is able to open and save Word, Excel and PowerPoint files automatically. Where necessary, OpenOffice.org can also be specified as the default application for Word, Excel and PowerPoint files. The compatibility between OpenOffice.org and Lotus SmartSuite is partly automatic. The compatibility requires that users know which file formats are supported by both software packages.

Also the need for support services and training were evaluated in the study. The evaluation revealed that there is no need for an external Help Desk agreement with an external service provider for OpenOffice.org user support. The need for support appears seldom and expert services should be acquired on a case-by-case basis. The installations of OpenOffice.org software versions can be done as internal work. External technical support services should also be acquired on a case-by-case basis.

The results of this case study should help managers in other organizations to better understand the various factors and conditions that affect the migration to an open source office suite software. The migration has produced several support tools and an extensive set of Finnish-language handbooks especially tailored for OpenOffice.org migrations. Also excessive documentation has been made freely available for IT professionals and managers. This all should help IT professionals both in the design and in the implementation of migration projects.

The migration is still in progress. Further results can be expected e.g. regarding application integrations and cost evaluations.

² http://wiki.services.openoffice.org/wiki/Market_Share_Analysis

References

- CNIPA (15 September 2004). "*Comparazione tra suite di produttività individuale. Rapporto del gruppo di lavoro*". Centro Nazionale per l'Informatica nella Pubblica Amministrazione (available online at http://www.cnipa.gov.it/site/_files/Rapporto%20conclusivo.pdf).
- Devoteam (11 May 2005). "*Choosing an Office Suite. Decision support based on six migrations to MS Office 2003 and OpenOffice.org respectively*". Devoteam Fischer & Lorenz and Danish Ministry of Science, Technology & Innovation (available online at http://www.oio.dk/files/English_Summary-13714-v1-Desktop_Evaluation_-_pdf).
- ECMA (7 December 2006). "Ecma International approves Office Open XML standard". Ecma International (available online at http://www.ecma-international.org/news/PressReleases/PR_TC45_Dec2006.htm).
- Fitzgerald B. (2006), "The Transformation of Open Source Software", MIS Quarterly, vol. 30, no. 3, 587-598.
- Friman, J., and Karjalainen, M. (12 September 2006). "*OpenOffice.org version 2. Installation handbook*". Ministry of Justice, Operations and administration 2006:27, ISBN 952-466-391-0 (95 pages, in Finnish, available online at <http://www.om.fi/Etusivu/Julkaisut/Julkaisusarjat/Toimintajahallinto/Toiminnanjarahallinnonarkisto/Toimintajahallinto2006/1157538492255>).
- IDA (4 November 2004). "*Dutch City of Haarlem migrates to OpenOffice*". European Commission, IDA programme (available online at <http://europa.eu.int/idabc/en/document/3434>).
- IDA (1 June 2004). "*TAC approval on conclusions and recommendations on open document formats*". European Commission, IDA programme (available online at <http://europa.eu.int/idabc/en/document/2592/5588>).
- IDABC (7 July 2006). "*French administration opts for OpenOffice*". European Commission, IDABC programme (available online at <http://ec.europa.eu:80/idabc/en/document/5695>).
- IDABC (17 January 2005). "*New Danish Report on Pilot Projects with OpenOffice and Microsoft Office*". European Commission, IDABC programme (available online at <http://europa.eu.int/idabc/en/document/3776/469>).
- ISO (8 May 2006). "*ISO and IEC approve OpenDocument OASIS standard for data interoperability of office applications*". International Organization for Standardization (available online at <http://www.iso.org/iso/en/commcentre/pressreleases/2006/Ref1004.html>).
- Karjalainen, K., and Karjalainen, M. (23 October 2006). "*OpenOffice.org version 2. Handbook of questions and answers. Second, revised edition*". Ministry of Justice, Publications 2006:12. ISBN 952-466-308-2 (252 pages, in Finnish, available online at <http://www.om.fi/Etusivu/Julkaisut/Julkaisusarjat/Julkaisuja/Julkaisujenarkisto/Oikeusministerionjulkaisuja2006/1161942336573>).
- Karjalainen, M. (12 October 2006). "*Final report of the OpenOffice.org pilot of the Ministry of Justice*". Ministry of Justice, Operations and administration 2006:29, ISBN 952-466-393-7 (78 pages, in Finnish, available online at <http://www.om.fi/Etusivu/Julkaisut/Julkaisusarjat/Toimintajahallinto/Toiminnanjarahallinnonarkisto/Toimintajahallinto2006/1160733641585>).
- Karjalainen, M. (18 May 2006). "*OpenOffice.org version 2. Handbook of questions and answers*". Ministry of Justice, Operations and administration 2006:19, ISBN 952-466-383-X (73 pages, in Finnish, available online at <http://www.om.fi/Etusivu/Julkaisut/Julkaisusarjat/Toimintajahallinto/Toiminnanjarahallinnonarkisto/Toimintajahallinto2006/114950896931>).
- Karjalainen, M. (11 March 2005). "*Office software evaluation for the administrative sector of the Ministry of Justice. Lotus SmartSuite, Microsoft Office, OpenOffice.org*". Ministry of Justice, Operations and administration 2005:4, ISBN 952-466-238-8 (35 pages, in Finnish, available online at <http://www.om.fi/Etusivu/Julkaisut/Julkaisusarjat/Toimintajahallinto/Toiminnanjarahallinnonarkisto/Toimintajahallinto2005/1145624743414>).
- OASIS (1 May 2005). "*OpenDocument v1.0 Specification. OASIS Open Document Format for Office Applications (OpenDocument)*". Organization for the Advancement of Structured

- Information Standards (available online at <http://www.oasis-open.org/committees/download.php/12572/OpenDocument-v1.0-os.pdf>).
- OGC (28 October 2004). "*Open Source Software Trials in Government - Final Report*". UK Office of Government Commerce (available online at <http://www.arb.ca.gov/oss/articles/report-v8d.pdf>).
- Poulsen, J., Birk, J., Hørlück, J., Jørgensen, N., and Pedersen, M. (2002). "*Open source software in e-government. Analysis and recommendations drawn up by a working group under the Danish Board of Technology*". Danish Board of Technology (available online at http://www.tekno.dk/pdf/projekter/p03_opensource_paper_english.pdf).
- Russo, B., Braghin, C., Gasperi, P., Sillitti, A., and Succi, G. (2005a). "Defining TCO for the Transition to Open Source Systems". In Marco Scotto and Giancarlo Succi (eds.), *Proceedings of the First International Conference on Open Source Systems*, pp. 108-112, Genova, Italy (available online at <http://oss2005.case.unibz.it/Papers/82.pdf>).
- Russo, B., Scotto, M., Sillitti, A., and Succi, G. (2005b). "Criteria for the non invasive transition to OpenOffice". In Marco Scotto and Giancarlo Succi (eds.), *Proceedings of the First International Conference on Open Source Systems*, pp. 250-253, Genova, Italy (available online at <http://oss2005.case.unibz.it/Papers/83.pdf>).
- Russo, B., Sillitti, A., Zuliani, P., Succi, G., and Gasperi, P. (2005c). "A Pilot Project in PAs to transit to an Open Source Solution". In Lois Delcambre and Genevieve Giuliano (eds.), *Proceedings of the 2005 national conference on Digital government research*, pp. 303-304, Atlanta, Georgia, U.S.A. (available online at http://diggov.org/library/library/dgo2005/poster/sb/rosso_pilot.pdf).
- Vestin, J. (2003). "*Interoperability test and XML evaluation of StarOffice Writer and Office Word 2003 Beta 2*". The Swedish Agency for Public Management, Dnr 2003/122 (available online at <http://www.statskontoret.se/upload/Publikationer/2003/2003116.pdf>).

Appendix. OpenOffice.org user questions

General topics

- (1) How do I install OpenOffice.org on a Windows computer?
- (2) How do I upgrade to a newer OpenOffice.org version?
- (3) Does OpenOffice.org require a Java run-time environment?
- (4) What are good OpenOffice.org user settings?
- (5) How much RAM does OpenOffice.org require?
- (6) Does OpenOffice.org increase the size of the Windows profile?
- (7) How do I install and activate Finnish spelling and hyphenation?
- (8) How can I get a Swedish user interface for OpenOffice.org?
- (9) What are the XML file formats used by OpenOffice.org?
- (10) Can I assign Microsoft Office file formats as the default save formats?
- (11) How can I set the default application for Microsoft Office files?
- (12) What are the shortcut keys of OpenOffice.org?
- (13) How can I enable/disable the OpenOffice.org Quickstarter?
- (14) How can I use document templates?
- (15) How can I assign my own document template as the default document template?
- (16) How do I find the style settings of a document?
- (17) Can I transform a Microsoft Office file to PDF format?
- (18) Does Acrobat Reader display the PDF files generated by OpenOffice.org?

Text processing – OpenOffice.org Writer

- (1) Is OpenOffice.org compatible with Lotus SmartSuite WordPro?
- (2) Is OpenOffice.org compatible with Microsoft Word?
- (3) What file formats does Writer read?
- (4) What file formats does Writer save?
- (5) How do I copy text from elsewhere to a Writer document?
- (6) How can I create a document template from a text document?
- (7) Can I use text abbreviations?
- (8) What are the shortcut keys of text processing?
- (9) How do I set my own shortcut keys?
- (10) How do I find out the differences between two documents?
- (11) How do I use spelling in Finnish?
- (12) How do I hyphenate the Finnish text?
- (13) How do I use spelling and hyphenation in foreign languages?
- (14) How can I prevent a line break between two words?

- (15) How do I insert non-breaking hyphens?
- (16) How can I disable the display of conditional hyphens?
- (17) How can I make tab stops and return characters visible?
- (18) How do I set tab stops and indents?
- (19) How do I define a hanging indent as specified in the Finnish standard?
- (20) How do I use bullets and numbering?
- (21) How do I create headers and footers and insert date and page number fields?
- (22) How do I make a different layout for the first page?
- (23) How do I apply heading styles and generate a table of contents?
- (24) How can I add empty space between the numbers and titles in the table of contents?
- (25) How can I create watermark background for each page?
- (26) How can I prevent automatic formatting of the text?
- (27) How can I prevent automatic word completion?
- (28) How do I restore text back to default format?
- (29) How can I display/hide line numbers in the document?
- (30) How do I remove in Word the highlight marking of text made in OpenOffice.org?
- (31) How can I disable the display of background colour in page number and date fields?

Spreadsheets – OpenOffice.org Calc

- (1) Is OpenOffice.org compatible with Lotus SmartSuite 1-2-3?
- (2) Is OpenOffice.org compatible with Microsoft Excel?
- (3) What file formats does Calc read?
- (4) What file formats does Calc write?
- (5) How do I open and save text files in Calc?
- (6) How do I refer to cells and cell areas in Calc?
- (7) How do I use the cell of another table (sheet) in a formula?
- (8) How can I automatically generate series in consequent cells?
- (9) How do I calculate the sum, number and average of cells?
- (10) How do I use the Function Wizard?
- (11) How do I transform the information in a table into a chart?
- (12) How do I format the dates of the cells?
- (13) How do I assign the border line settings of the cells?
- (14) How do I assign the background colour of the cells?
- (15) How do I create headers and footers for tables?
- (16) How do I use spelling in a spreadsheet?
- (17) How do I control line breaks in the cells of a table?
- (18) How do I print only a selected table (sheet)?

- (19) How can I print a table in the landscape format?
- (20) How can I adjust the height and width of printing?
- (21) How can I insert and remove page breaks?
- (22) How do I lock the rows and columns of a table?
- (23) Why isn't the number representation of date 1.1.1900 the same in Calc and Excel?

Slide presentations – OpenOffice.org Impress

- (1) Is OpenOffice.org compatible with Lotus SmartSuite Freelance Graphics?
- (2) Is OpenOffice.org compatible with Microsoft PowerPoint?
- (3) What file formats does Impress read?
- (4) What file formats does Impress write?
- (5) How do I add new slides to the presentation?
- (6) How do I add slides from another presentation?
- (7) How do I hide slides from the presentation?
- (8) How do I create slide headers and footers with date and page numbering fields?
- (9) How do I show the presentation without page numbers and dates?
- (10) How do I set the background of the slides?
- (11) How can I create a presentation template from a slide presentation?
- (12) How do I use spelling in a presentation?
- (13) How do I hyphenate the text of the presentation?
- (14) How do I adjust the slide contents to fit the print paper size?
- (15) How do I print several slides on one sheet?

From Closed Source and Open Source to Shared Source: a New Business Model for Independent Software Vendors?

Mikko Riepula

Helsinki School of Economics, Finland

mikko.riepula@wificom.com

Abstract. This paper first presents the current state of art in traditional licensing of proprietary software as well as open-source software (OSS), particularly from the vantage point of a small independent software vendor (ISV) who needs to resort to integration services by more established partners. Various explaining factors pro and con OSS are introduced from earlier literature. This paper then presents an idea on how ISVs can license their technology commercially through arrangements that take advantage of collaborative working methods employed by OSS communities—an idea that may not be completely new, but something that deserves more attention now that OSS has entered the mainstream corporate world and OSS communities are beginning to accept the commercialisation of OSS. Although already introduced by Microsoft in a slightly different manner, this could be considered a new business model for independent software vendors (ISVs) and is called *shared source*. Shared source is very commercial, largely proprietary and is not OSS in the strict sense, although it resembles OSS in many ways. A case of a small ISV in the telecom sector is presented. This paper aims at initiating discussion on the topic of this kind of shared-source licensing and sets certain directions for future research.

Keywords. Open-source software, open source, IS development, software licensing, shared source, business model.

Introduction

Traditional wisdom suggests that a key asset for any software vendor is their source code, which is the technical embodiment of their intellectual property rights

(IPR). Keeping it proprietary and closed, i.e. not giving access to it to clients or even partners, has been widely regarded as an obvious way for independent software vendors (ISVs) to protect their IPR. Recently an alternative open-source philosophy has emerged from the grass roots level and has evolved into something that has also business credibility but that has not proven to be very profitable for companies basing their strategy solely on or around open-source software (OSS). (Cusumano 2004).

We begin this paper by taking a short look at the traditional and most obvious licensing methods in software business. We then describe the state of the art in OSS based on a literature survey. Then we discuss ways in which traditional closed-source business can be selectively opened up as regards the availability of source code, without necessarily making it all OSS in the strictest sense, which results in certain interesting opportunities particularly for small ISVs. Based on our industry experience, we have a reason to believe that the model suggested herein, called *shared source*, is an underexploited idea that has not been widely practiced but probably will become more prevalent as ISVs try to find ways to compete against not only each other but also against the increasing number of OSS offerings. Research is lacking in this respect, however, and the present paper aims to start a discussion that will help researchers direct their future efforts.

Traditional Closed-Source Software Licensing

The holy grail of software business has been to come up with an innovative software product that can be sold to the masses at very low marginal cost. While this remains the goal for many ISVs, it is also a very elusive goal. In reality, most ISVs find themselves customizing their offering to different client groups or even individual clients, which significantly increases the marginal sales and delivery costs. In other words, these ISVs find their businesses becoming more and more service businesses as opposed to product businesses (Cusumano, 2004).

If a vendor of proprietary software wishes to offer customized solutions to its clients, traditional wisdom has it that the ISV has two choices:

- (1) The ISV can make the customizations itself, which obviously entails a lot of effort and is subject to the communication gap between the ISV and the client when it comes to assessing the client's real needs and translating those into the ISV's language of technical requirements (Thomke and von Hippel, 2002). Additionally, question being on software projects, the ISV usually takes a huge risk in trying to assess the amount of work required, if it offers to do the work for a fixed price. Product houses (ISVs) are not experts in selling custom projects and can pay a high price for learning to sell and deliver projects profitably (Nambisan 2001), whereas offering a

- customization or integration project at a variable price obviously presents the client with a risk it may not find acceptable. Or,
- (2) the ISV can seek to work in partnership with an integrator, who is an expert in the service business in the sense of Nambisan (2001) and Cusumano (2004). The communication gap in the sense of Thomke and von Hippel (2002), is still there, even if this time it is the integrator partner, not the ISV, who needs to understand the complex, subtle and fast-changing customer needs as well as to educate the customer on what is possible and where its requirements may even be self-contradictory. If the custom modifications are such that the ISV needs to give the integrator access to the source code (under what is sometimes called a “development license”), it is in the ISV’s best interests to insist that any further development will also become its IPR, as it very difficult to draw the line between original and derivative works and particularly to isolate the difference between the two as a piece of IPR that would be distinct from the original IPR. Of course, if the product design is modular enough not to require releasing source code to the integrator, then it is invariably either the integrator that will keep the IPR and the source code related to the extensions developed for the client or it may be the client that buys the IPR to these extensions from the integrator, but typically not the ISV. Thus the ISV will not capitalize on the development done by the integrator unless it has managed to negotiate a contract whereby such changes and all related IPR would be transferred back to the ISV, which again is foreseeable only if the ISV had to release the source code to the integrator. The co-ordination of efforts of multiple integrators is only possible through the ISV’s active involvement and can be very difficult due to varying development and version control methods used by different integrators, and in general due to the integrators working in isolation and “out of synch”, yet simultaneously, on overlapping parts of the code. In fact, it can become so difficult as to prevent the ISV altogether from capitalizing on the incremental development done by an integrator, even if it had the contractual rights to incorporate those improvements into its product.

A number of vendors also sell proprietary platform software that may often by nature require selling code in its source code format. Although their source code is not completely closed, the tendency has been for these vendors to only deliver the minimal set of source code, such as relevant parts of the application programming interface (API), and to provide the rest of the platform in the form of binary libraries. This kind of software acts as an enabler for other ISVs and is not a complete piece of software performing an end-user function as such. An example would be a GUI widget library or application server middleware.

Many commercial vendors also offer source code even for free in the form of software development kits (SDKs) or, particularly operating system vendors, driver development kits (DDKs). Like in the above cases, the extent of source code provided is without exception very limited and the modification and redistribution rights allowed to third parties are granted by the original vendor solely in order to boost its own sales of the base product, to which these third parties develop extensions (Matusow 2005).

It has been taken almost for granted that it is those companies who manage to protect their source code furthest while giving their partners the possibility to develop extensions to their products, e.g. Microsoft, that are best positioned in the long run to get returns on their development investments. The open-source movement has changed some of those attitudes, even if commercial success with OSS is not yet anywhere near that of closed source.

Open-Source Software

The present chapter describes the *raison d'être* and state of the art in OSS, and, together with the following chapter, serves as an up-to-date literature survey on the topic before we tackle the more interesting issues around shared-source software. We will see that the research on OSS so far has been preoccupied with explaining the emergence of OSS, studying its acceptance in firms or drilling down into the OSS communities as loose organizations. Lately efforts have been made to build comprehensive taxonomies of business models around the commercial use of OSS, but what is of current interest to us is the ongoing fusion of traditional licensing of proprietary technology and pure OSS in a highly commercial setting. Matusow (2005) talks about “a move to the middle” and Fitzgerald (2006) has coined the term “OSS 2.0” to refer to largely the same shift.

History and a Short Definition

Eric S. Raymond's short essay “The Cathedral and the Bazaar” from 1997 is commonly regarded as a manifesto of the open-source movement. In his view the bazaar model, whereby the code being developed is visible to all on the Internet and anyone can also suggest improvements and bug fixes to it, is a *more efficient way of organizing software development by, paradoxically, organizing less*.

As the phenomenon grew, researchers also became interested in explaining its emergence. The following research papers could be considered seminal in the field: Hecker (1999), von Hippel (2002), Lerner and Tirole (2002) and to some extent also Lakhani and Hippel (2003) and O'Mahony (2003).

The Open Source Initiative (OSI) defines OSS as software fulfilling 10 criteria¹; most importantly: OSS is (1) freely redistributable, its license not restricting any party from bundling it for sale or giving it away and not requiring royalties, with (2) source code made available in a way that also (3) allows any modifications and derived works to be distributed under the same license terms.

The GNU Public License (GPL), or “copyleft”², has become a classic in the field. The strong condition of the GPL is that any derivative works shall also be contributed to OSS under the GPL, which can be problematic to OSS companies. This is referred to as a *reciprocal* license (Fitzgerald, 2006).

While dozens of different community-driven, *academic style* OSS licenses have emerged, at least Apple, IBM, Intel, Lucent, Nokia, Sun and Sybase have also published their own, OSI-approved, *corporate type* open-source licenses. Even if OSI-approved, at least Apple Public Source License and Sun Community Source License are not considered OSS licenses by some, as they protect copyright (Bonaccorsi and Rossi, 2003). In fact, they come closer to the shared-source concept described later in this article and belong to the *non-approved* category in Fitzgerald’s (2006) typology.

Today, OSS has found its way to the corporate world and one could argue that the OSS communities have largely come to terms with the commercial use of OSS, as is further explained by Fitzgerald (2006) under the term “OSS 2.0”.

Teece’s Model of Profiting from Innovations

Many OSS researches have referred to Teece’s work (1986) on appropriability regimes. First of all, in order for an innovator to be financially rewarded for his innovations, he needs to consider both the technology as such (can it be easily copied?) and the legal protection methods. Secondly, sooner or later, if an innovation is successful, it will form a *dominant design* in its field. From thereon, success on markets with diminishing prices is more related to *complementary assets* than access to proprietary technology which, by this definition, is no longer a differentiator.

Kampas (2003) has viewed the above as a function of the type of innovation necessary. In the early stage of a high-tech industry, market success depends on *product innovation* based on proprietary technology. Ultimately, when a dominant design emerges, commoditisation begins and companies need to innovate with complementary assets such as marketing, efficient operations, after-sales support etc. in order to be competitive. Focus moves from *product* innovation to *business* innovation.

¹ <http://www.opensource.org/docs/osd>, last accessed 27 March 2007.

² <http://www.gnu.org/copyleft/gpl.html>, last accessed on 25 March 2007

This is in line with Cusumano's (2004) experiences: many software companies start as *product companies*, i.e. focussing on technological innovation and design of their product as their competitive edge. However, the same companies are almost invariably forced to change into *service companies* as they grow and the business matures, leveraging their existing customer relationships, since it is unlikely that innovation will continue at the same high initial level that first brought the product about.

It should be clear from the above that OSS companies are less likely to rely on product innovation for their revenue. The revenue will most likely come from business innovation, or using Teece's wording, from complementary assets, be those services or incremental commercial products complementary to the original OSS product.

Open Sharing as a Natural Step during the Exploration Phase

Osterloh and Rota (2007) give their explanation based on technology maturity models and explain how the exploration phase (also described by Anderson and Tushman, 1990; Teece, 1987; etc.) preceding the era of a dominant design is conducive to open sharing of information. They conclude that OSS fits the definition of collective innovation in the sense of Allen (1983). They would expect this collective invention mode to break down, as suggested by Meyer (2003), but found that "the OSS model survives the emergence of a dominant design, and thus shows a promising way to a new innovation model." To explain OSS as an exception, motivational factors need to be taken into account:

The continuing success of the collective invention regime in OSS depends to a large extent (a) on a balance between intrinsic and extrinsic incentives to contribute to the first-order public good (source code) and (b) [on] the pro-social intrinsic motivation of a sufficient number of participants to contribute to the second-order public good (enforcing the rules of cooperation). (Osterloh and Rota, 2007)

Motivational Aspects of Developer Activity

There is ample research (see e.g. the references section in Rossi and Bonaccorsi, 2005) to show that both extrinsic and intrinsic motivations move OSS developers. Rossi and Bonaccorsi (2005) add the ideological fight against proprietary software to the list of intrinsic incentives. See also Bonaccorsi and Rossi (2003). Pykäläinen (2006) even takes this ideological aspect as a kind of success factor.

When volunteers take up a certain programming task, motivated as above, and select the various open tasks based on their own skills and level of experience, it is easy to understand how high motivation and specific skills lead to high quality.

User Innovation

Another way to explain the emergence of OSS is through *user innovation* as introduced by von Hippel (2002) and Thomke and von Hippel (2002): users are often the best experts in determining *what* should be changed in software, and, equipped with the source code, knowledgeable users can even be the best people to determine *how* to change the source code. They are, however, far from being the best people to market the software, especially when their own contribution remains relatively small. Recognising this, an individual user innovator is willing to give away his incremental development often for free, his only wish being that others would also incorporate his change before developing the product further and would thus keep the future improved product versions compatible with his own needs. Harhoff et al. (2003) explain the same by how the transaction cost alone can be prohibitive for user innovators to license their innovations. (See also Osterloh and Rota, 2007)

Open Source as a Marketing Activity as Opposed to a Core Value

Members of the OSS community are often seen as trustworthy, enthusiastic, and even altruistic. Companies may also try to ride on this image and that may sometimes serve as their main motivation to participate in OSS projects. A company may not even really participate in an OSS project, but by using OSS-friendly announcements it may try to win the hearts of its prospective clients.

At least Bonaccorsi and Rossi (2005) and Osterloh, Kuster and Rota (2002) have examined this aspect of OSS and in particular the discrepancy between attitudes and behaviours of companies. Bonaccorsi and Rossi (2005) conclude that in most of the 146 cases of Italian OSS firms studied, the positive attitudes are not put into practice and that the very participation to the OSS community is scanty.

Also Dahlander and Magnusson (2005) touch upon the topic and view the relationships between companies and the OSS communities as symbiotic, commensalistic or parasitic.

Business Models around OSS

Above we described how research has explained the emergence of OSS. Here we show how the above can take a commercial shape and manifest itself in different business models. A business model is an appearance of business strategy as a combination of *product* proposition, *services and implementation* model, *distribution* model and *revenue* logic (Rajala et al., 2001).

We first made a synthesis of Hecker's (1999) classification of different OSS business models with that of Karels's (2003) and then eliminated those that are not relevant to the upcoming discussion in our article, resulting in the following list. See also Krishnamurthy (2003, 2005).

- **Support Sellers.** Support in general can range from simple email/phone assistance with installation to very specialized expert help by developers who are deeply involved in the OSS project in question and who can submit code back to the project. An obvious example is RedHat.
- **Contract Developers.** Consulting activity in the sense of further technical development work for a particular client is a natural extension of pure support business, cf. integrators. The resulting code may or may not be contributed back to the original OSS project.
- **Loss-Leaders** bundle OSS with proprietary software. Karels (2003) calls these **Commercial Value-Adders**. Many OSS licenses allow the bundling of proprietary software with OSS and selling it for a fee. An OSS company could also provide extensions or a professional version under a commercial license while offering a free limited version for non-commercial use.
- **Dual Licensors.** An interesting variation of the above is a model whereby a non-commercial version is made available under a license such as GPL and a commercial version is sold for a significant fee. This is sometimes referred to as a “poison pill”: the code is readily available for any ISV to use, but should an ISV start selling its own product bundled with such a dual-licensed product, it either needs to buy a commercial license or it risks having to release all of its own code under GPL. MySQL, Sendmail and Perl are some of the best-known examples in this category.
- **Commercial Enhancers of OSS** are otherwise the same as Commercial Value-Adders above but modify the original product instead of treating it as a separate module.
- **“Sell It, Free It” Companies** are those who have nothing more to lose by releasing their product as OSS. This may happen after the product is no longer providing interesting revenue streams to the company as a stand-alone product.

Pykäläinen (2006) has preferred to develop a 3 x 3 x 3 matrix model for classifying the business models based on openness of technology, ideology towards openness and type of complementary assets (whether generic, mixed or critical to the business model).

Use of OSS by ISVs

In this chapter we look at OSS particularly from the B2B viewpoint of an independent software vendor (ISV)—in other words, why should ISVs care for OSS? Even if OSS may sound appealing, what are the issues in using OSS for competitive advantage or in trying to launch a new OSS project altogether?

An ISV Using an OSS Platform or OSS Components

Firstly, an ISV can offer its own, for-charge product on an OSS platform and thus lower the end client's total cost for acquiring the software and installing it in a suitable software environment, even if the *total cost of ownership* (TCO) is not zero with OSS either. (See e.g. Russo et al., 2005, for the TCO aspect.) An ISV may also save significantly in development costs by using OSS components in its product instead of in-house development or sourcing from a commercial vendor.

But using OSS too tightly with one's for-charge software product may be in breach of the OSS license. GPL is the most problematic and the following questions easily arise. When are two pieces of source code essentially the same? What constitutes an original design and what is a copy of a GPL-licensed product or part? When are the additions sufficiently separate not to require releasing the ISV's own product under GPL?

... some companies seem to skirt the limits of the GPL. For example, some vendors provide non-GPL commercial products that are dynamically linked with the Linux kernel (which is covered by the GPL) or are shipped as binary modules for their customers to link into Linux. (Karels, 2003).

Some OSS vendors, e.g. MySQL, have come up with a dual licensing scheme: ISVs aiming to sell their products bundled with the MySQL database engine need to buy a commercial license unless they want to be bound by the GPL, which again could make their business case null and void.

If an ISV using OSS as a basis for its business does not contribute back their incremental developments, the community may tackle the same issues in a different way or even deprecate APIs for which no visible use is seen (Mannaert and Ven, 2005). In any case, not contributing means not keeping the internal development and open source code in synch and results in two easily divergent code bases. An ISV thus has an incentive to contribute back to OSS.

However, it is not that easy for an ISV to get its extensions or modifications accepted by the open-source community that scrutinizes the code for ensuring quality and adherence. Even for a producer of high-quality software, it may take time and effort to learn the processes and practices of open-source community and gain acceptance within it. Some of the ISV's modifications to the OSS application will also be too specific to be included in a project open to all. (Mannaert and Ven, 2005; von Hippel and von Krogh, 2003.)

An ISV Launching Their Product as OSS

Secondly, an ISV may think about transitioning into one of the aforementioned OSS business models as its product matures, for the reasons presented in the beginning. An ISV with a software product that is making the company money may understandably be reluctant to contribute its product as OSS, which as such is

an irreversible action. Even if an ISV wanted to launch their product as OSS, practical inhibitors exist (Mannaert and Ven, 2005; Matusow, 2005):

- There is a need to provide the necessary infrastructure for version control, bug/request tracking and discussion forums.
- The more the ISV's project is specific, the fewer are the contributors it is likely to attract.
- Commercial software often contains components that originated from elsewhere. An ISV may not be allowed to publish all those components as OSS, if it intends to publish the whole.
- The quality of the code and the style of comments in the code may not be up to publishing standards.
- The legal ramifications and risks associated with incremental developments by the OSS community need to be addressed by the ISV, if it is to take advantage of those commercially e.g. through dual licensing.
- Documentation typically has not been completed with code reuse in mind.

Rather than eternally contemplating the transformation into an OSS business, an ISV with a proprietary product could perhaps better benefit from the model described in the following Chapter.

Shared Source: An Overlooked Opportunity?

In the following we present a combination of the closed-source and open-source approaches, reminiscent of *shared source* by Microsoft as introduced by Matusow (2005). We use the term “shared-source software” (SSS) in a slightly different meaning, which we believe is clearer and crisper in its definition and practical implications and which may well be beneficial especially to ISVs who cannot afford to build a network of integrators who would again work with end clients, i.e. small ISVs. It may also be a good way to still try to extract some surplus from previous development work in a situation where the ISV no longer can or wants to maintain the code base alone, and this in a way that the irreversible decision of publishing the source code as OSS need not be taken. The benefits from user innovation in the sense of Thomke and von Hippel (2002) that result from SSS are obviously applicable in a wider setting and with larger ISVs as well.

It would at first appear surprising if many ISVs were not already practicing this kind of licensing. However it may well be that due to the concerns relating to IPR protection and the co-ordination efforts required, those ISVs are quite shy about their plans when it comes to sharing source code. Although Microsoft has built their shared-source initiative since 2002, it has so far remained in the shadow of

the more traditional business Microsoft carries out (Cusumano, 2005). Also, despite the publicity OSS has attracted, only few companies truly embrace the openness called for in OSS communities (see e.g. Rossi and Bonaccorsi, 2005)—probably exactly because of these kinds of concerns with IPR protection.

At least dual licensors have business models that resemble SSS as described herein, yet they differ in central aspects such as availability of source code to the general public. So far the author is only aware of one other research publication focusing on the topic, namely that of Matusow (2005), in which many of the same elements can be found. The commercial viewpoints of small ISVs are quite different from that of Microsoft though; furthermore, the level of technical complexity may be very different.

Fitzgerald (2006) defines the OSS 2.0 model as something that also covers SSS, even if SSS does not fit the traditional definitions of OSS.

The Essence of Shared Source

The basic idea is simple: an ISV can keep its source code proprietary while licensing it to its clients and providing them with what Thomke and Hippel (2002) call “tool kits for customer innovation”, i.e. source code versioning tools, an end-client discussion forum that brings such clients together, etc., quite akin to practices in the OSS community.

A central element of such an SSS arrangement is obviously the license agreement between the ISV and the client. A key aspect of SSS is that the license for the core product is *not* an OSS license but restricts the use and distribution of source code to the client organization only, and that there is obviously a price, which again can be substantially higher than the price charged for a regular run-time version. Unlike with Matusow (2005), our definition of OSS covers only products for which the source code is shared or opened in its entirety. In the below example dealing with an ISV in the telecom sector we will further discuss how OSS licensing can be effectively combined with SSS in a modular product design.

The SSS license agreement may be quite different in pricing from client to client, as when the price grows largely beyond that of a run-time license it justifies a more thorough sales process and allows more price customization. The source code can be licensed both with rights to resell the software in its run-time version and without such rights. In all cases, the ISV would forbid the reselling of the source code further, since that is the business of the ISV itself that it wants to protect from competition.

The SSS license agreement should encourage the license holders to contribute their changes back to the shared-source project site, so as to potentially benefit other parties involved, but also in a way that any changes become IPR of the ISV. As discussed above with OSS, a shared-source client also has a strong interest to try to have their own improvements accepted in the main branch of the shared-

source development project so that those become part of the maintained code base.

The ISV has two options as to the co-ordination of the development efforts amongst its clients and project administration: either to oversee it itself, or to appoint a lead developer organization among its clients. In either case, the purpose of such co-ordination should not be to direct or limit the clients' development as such. Instead, the co-ordination is required, just like in any OSS project, to resolve questions such as which of two alternative and mutually exclusive designs is adopted for future shared-source versions, and even this should probably be done in a very consultative or "democratic" manner if the benefits of OSS-style development are to be expected. Indeed it is expected that such a party becomes more of a project administrator in the bazaar, taking care of the collaborative environment conducive to sharing the developments and facilitating communications also when it comes to joint requirements analysis.

Many of the benefits of SSS are the same as with OSS. The target audience for SSS is a lot smaller, but it is a well-defined group of real clients with a demonstrated interest in the software. The ability to provide their product in the source code format should be a distinct competitive advantage and differentiator for the first movers in a commoditized market. We would expect—based on nothing else than business intuition at this stage—that the critical mass of SSS clients, after which the network effect becomes a compelling element in the offering, to be in the order of five to ten clients.

SSS also poses certain challenges to the ISV. Compared to traditional proprietary licensing, SSS obviously increases communication between the clients and hence the discrimination with license prices could prove to be more difficult³. It is by no means impossible however, since clients buying software are very used to being charged license fees based on the value of the software to their organization, or at least based on the extent or intensity of use. Furthermore, if the ISV had built in a license manager or similar mechanism into the product to enforce the limitations of the license technically, these limitations are no longer effective. SSS also increases the risk of leaking IPR, and thus revenue, into hands of unauthorized organizations, be those prospective clients or competitors. Needless to say, non-disclosure clauses are a necessity.

Microsoft's Shared-Source Initiative

Since 2002, Microsoft has been building their shared-source initiative. Matusow (2005) stresses that most of Microsoft's shared-source clients, such as large corporations or governments, appreciate the *option* of having access to the source

³ An extreme approach can also be envisaged whereby clients are assigned pseudonyms and are only allowed access to moderated discussion forums whereby the identity of each client can be kept secret from others.

code at certain conditions, since transparency increases trust. He assesses that only about 5% of those involved even look at the source code while less than 1% are able or willing to actually modify it. In Microsoft terminology,

shared source is a framework, not a license. [...] Microsoft's licensing approach ranges from reference-only grants (where licensees may review Microsoft source code for the purposes of reference and debugging, but are not granted modification or redistribution rights) to broad grants that allow licensees to review, modify, redistribute, and sell works with no royalties paid to Microsoft. (Matusow, 2005)

It remains somewhat unclear to what extent Microsoft actually benefits from the modifications made by this less-than-1% minority and how collaborative, or OSS-like, their development methods are. A clear difference between our SSS concept and that of Microsoft is that user communities are not *central* in Microsoft's business model.

Furthermore, when Matusow (2005) states that "all the current source code programs from Microsoft are provided at no cost," it obviously raises the question of the true revenue model behind the initiative. He explains that their shared source covers the following four concepts, which partly answers the question:

1. Supporting existing customers,
2. Providing instructional source code through code samples,
3. Augmenting teaching and research, and
4. Promoting partner opportunity for mutually advantageous new business.

Matusow (2005) states that "the source code you share does not have to represent 100% of a product", implying that few, if any, of the products that Microsoft shares in this manner are shared in full.

In the following case, SSS is proposed as a key part of its product development strategy. While different, the two cases have important similarities. Both can be called shared-source approaches to distinguish them from OSS, which they explicitly are not, and from purely closed source.

Case of a Small Nordic Telecom ISV

At this stage, the model outlined herein is at an experimental stage within a small but international Nordic telecom software vendor that has had moderate success with its product but whose resources were insufficient to further develop and maintain the code base once investors pulled out. The company has started licensing its source code to its end clients and is developing its business model towards the described SSS model. The ISV is going a little bit further by granularising the offering into a shared-source part and an open-source part, the latter part being available to all and of interest not only to shared-source clients but also clients with the run-time version only.

The ISV is a vendor of WLAN service management software that allows operators to deliver, charge for and manage public WLAN Internet access. Such a system is needed behind the obvious WLAN hardware components installed in a

so-called “hotspot”, be it an airport, hotel or conference centre. The software technology as such is independent of the access technology, whether WLAN, WiMAX or Ethernet cable. Although rewarded for an innovative and very promising business idea a few years ago, the ISV has during more recent times faced stifling competition from all fronts, be it other similar VC-funded ventures or large established telecom software vendors. This ISV’s operations and other products have embraced the open-source philosophy, but its strategic core product has always been kept proprietary.

Full Core Product Sold as Shared Source

Instead of “doing desperate things it may regret later”, such as releasing its core product as OSS and focusing on one of the aforementioned OSS business models (e.g. support seller or “sell it, free it”), the ISV has decided to make a difference by offering shared-source licensing to its core product along with the traditional run-time licenses, and offering complementary components such as interface modules to external systems as OSS.

APIs and Interface Modules Released as OSS

One of the success factors of the ISV in question is the number of different interface modules it can offer. Its clients use a number of different kinds of access gateways, payment service providers and roaming partners. Within each of these categories, the more choice the ISV has to offer the wider the audience that finds the offering attractive.

So far the ISV has developed these kinds of modules itself, in partnership with third parties, or in co-operation with the client. Every time a new implementation was made, it has since been advertised as yet another supported gateway, payment service provider (PSP) or roaming partner. Especially as regards PSPs, where the market is relatively fragmented with local variations, development has also been done by clients. In all cases, the maintenance or “dragging along” of these extensions, each with limited and varying degree of value to future clients, has proven to be a delicate matter when the base product has been further versioned. The ISV has had to estimate the potential of (1) clients already using the extension possibly later buying an upgrade and (2) new clients finding the extension valuable when deciding how much effort to put into testing of such a module in a new version or when deciding whether to follow-up the interfacing partner’s changes to ensure continued compatibility. In line with user innovations (Thomke and von Hippel, 2002) it seems this difficult yet critical task of resource allocation could be better achieved by clients themselves.

SSS could obviously be used to lower development costs in this respect as well, but by properly defining the APIs and allowing dynamic linking of such modules the ISV will be able to offer these kinds of interface modules even as OSS, which further widens the development community to those who have bought only a run-

time license. As Shapiro and Varian (1998) put it, “if you control a key interface or bottleneck, you should open it up—but on your own terms and conditions”. Furthermore it provides the ISV with a *signalling capability* to new prospective clients, who can assess for themselves what the level of integration is with the third parties they are interested in interfacing with.

The early phase of implementing SSS in the case company does not allow to draw very definitive conclusions at this stage, but we will continue to observe the case.

Conclusions

In this paper we have contrasted the state-of-the-art methods in closed source (proprietary) software licensing with those in OSS, particularly from the viewpoint of ISVs whose clients require customized solutions. A literature survey was carried out on OSS in general. In this paper we took a B2B viewpoint, whereby we discussed particularly the drivers behind ISVs engaging in OSS both as beneficiaries and contributors. We then introduced the idea of *shared-source* software (SSS) as a commercial arrangement that incorporates elements from OSS but is still proprietary. At least Microsoft is engaged in such an initiative that it has obviously tailored to suit its market position. However, SSS would also appear to be a particularly viable option for many of those smaller closed-source ISVs who have considered e.g. the “sell it, free it” business model, and in general to any ISV that has a reason to believe it could benefit from *user innovation* by its clients, whether direct end clients or integrators. SSS, as presented here, may not be a completely new idea, but neither does it seem to be reflected in research to the extent it probably deserves. Further empirical research is well justified to find out to which extent it is already being practiced and to find out the profit potential for such a business model. It might also be worth analyzing in detail how SSS differs from the practices of dual licensors, other than as regards availability of source code to a well-defined group only, or from *inner/corporate/community source* (Dinkelacker and Garg 2001; Gurbani et al. 2005). Is SSS mainly applicable to small ISVs like our case company or would it have wider interest? We would expect to be able to find a group of companies with business models that have essentially similar elements, and expect that researching those can shed valuable light on the question of how to make money with OSS 2.0 and, in particular, with SSS.

Acknowledgments

I would like to thank Helsingin Kauppakorkeakoulun Tukisäätiö for its financial support as well as Juho Lindman, Kari Yliluoma and anonymous reviewers for their comments.

Abbreviations

API	Application Programming Interface
B2B	Business-to-Business commerce
GNU	“GNU is Not Unix”, the recursive acronym of a classic OSS project.
GPL	GNU Public License
IPR	Intellectual Property Rights
ISV	Independent Software Vendor
OSI	Open-Source Initiative ⁴ , see http://www.opensource.org/ .
OSS	Open-Source Software
SSS	Shared-Source Software
TCO	Total Cost of Ownership
VC	Venture Capital(ist)
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network (largely synonymous with WiFi)

References

- Ajila S. A., Wu D. (2007). ”Empirical Study of the Effects of Open Source Adoption on Software Development Economics”, *J. Syst. Software* (2007), doi:10.1016/j.jss.2007.01.011. In press.
- Allen, R.C. (1983). “Collective invention”, *Journal of Economic Behaviour and Organisation* Vol. 4 No. 1, pp 1–24.
- Anderson, P., Tushman, M.L. (1990). “Technological discontinuities and dominant designs: a cyclical model of technological change”, *Administrative Science Quarterly* Vol. 35, pp. 604–633.
- Arrow, K. (1962). “Economic Welfare and the Allocation of Resources for Inventions”. R. R. Nelson (ed.) *The Rate and Direction of Inventive Activity*. Princeton University Press, Princeton, NJ, USA, pp. 609-625.
- Bonaccorsi A., Rossi C. (2003). “Why Open Source software can succeed”, *Research Policy* Vol. 32 (2003), pp. 1243-1258.
- Bonaccorsi A., Giannangeli S., Rossi C. (2006). “Entry strategies under competing standards: Hybrid business models in the open source software industry”, *Management Science*, Vol. 52, No. 7, July 2006, pp. 1085-1098.
- Conner, K. R., Prahalad, C. K. (1996). ”A resource-based theory of the firm: Knowledge versus opportunism”, *Organ. Sci.* Vol. 7, No. 5, pp. 477-501.

- Cusumano, M. (2004). *The Business of Software: How to Survive and Thrive in Good Times and Bad*. The Free Press, New York, NY, USA. 2004.
- Cusumano, M. (2005). "What Road Ahead for Microsoft the Company?" *Communications of the ACM*, Vol. 50, No 2, Feb 2005, pp. 15-18.
- Dahlander L., Magnusson M. G. (2005). "Relationships Between Open Source Software Companies and Communities: Observations from Nordic Firms", *Research Policy* Vol. 34, 481-493.
- Demsetz, H. (1967). "Towards a theory of property rights", *Amer. Econom. Rev.* Vol. 57, pp. 347-359.
- Deng J., Seifert T., et al. (2003). "Towards a Product Model of Open Source Software in a Commercial Environment". *3rd International Workshop on Open Source Software Engineering*. ICSE 03, Portland, OR, USA, 2003.
- Dinkelacker, J., Garg, P. (2001). "Corporate Source: Applying Open Source Concepts to a Corporate Environment", *Proc. of 1st Workshop on Open Source Software Engineering*, Toronto, May 15th, 2001. <http://opensource.ucc.ie/icse2001/dinkelackergarg.pdf>
- Feller J, Fitzgerald B., Hissam S. A., Lakhani K. R. (eds) (2005): *Perspectives on Free and Open Source Software*. Cambridge, MA, USA. MIT Press, 2005.
- Fink, M. (2003). *Business and Economics of Linux and Open Source*. Prentice Hall, NJ, USA, 2003.
- Fitzgerald, B. (2006), "The Transformation of Open Source Software", *MIS Quarterly* Vol. 30, No 3., pp. 587-598, September 2006.
- Gurbani, V. K., Garvert, A., Herbsleb, J. D. (2005). "A Case Study of Open Source Tools and Practices in a Commercial Setting," *Proceedings of the 5th Workshop on Open Source Software Engineering*, St Louis, MO, USA, May 17th, 2005, pp.24-29.
- Harhoff, D., Henkel, J., Hippel, E., von (2003). "Profiting from voluntary information spillovers: how users benefit by freely revealing their innovations", *Research Policy* Vol. 32, No. 10, Dec 2003, pp. 1753-1769.
- Hecker, F. (1999). "Setting Up Shop. The Business of Open Source Software", *IEEE Software* Vol. 16, No. 1, 1999, pp. 45-51.
- Hippel, E., von (2002). "Open Source Projects as Horizontal Innovation Networks—by and for Users", MIT Sloan Working Paper No. 4366-02, 2002
- Hippel, E., von, Krogh, G., von (2003). "Open Source Software and the 'Private-Collective' Innovation Model: Issues for Organization Science", *Organization Science*, Vol. 14, No. 2, March-April 2003, pp. 209-223.
- Kampas, P.J. (2003). "Shifting cultural gears in technology-driven industries", *MIT Sloan Management Review*, Winter 2003, pp. 41–48.
- Karels, M. J. (2003). "Commercializing Open Source Software. Many have tried, a few are succeeding, but challenges abound", *ACM Queue* July/August 2003, pp. 46-55. 2003 ACM 1542-7730/03/0700.
- Krishnamurthy, S. (2003). "A managerial overview of open source software", *Business Horizons* Vol. 46, pp. 47–56.
- Krishnamurthy, S. (2005). "An analysis of open source business models", in Feller et al. (2005) above, pp. 279-296.
- Lakhani, K.R., Hippel, E. von (2003). "How open source software works: 'free' user-to-user assistance", *Research Policy*, Vol. 32, No. 6, June 2003, pp. 923-943.
- Lerner, J., Tirole, J. (2002): "Some Simple Economics of Open Source", *Journal of Industrial Economics*, Vol. 52, 2002.

- Mannaert, H., Ven, K. (2005). "The Use of Open Source Software Platforms by Independent Software Vendors: Issues and Opportunities", *Open Source Application Spaces: Fifth Workshop on Open Source Software Engineering (5-WOSSE)* May 17, 2005, St Louis, MO, USA, 2005, ACM 1-59593-127-9.
- Matusow, J. (2005). "The Shared Source Initiative: The Microsoft Perspective", in Feller et al. (2005) above, pp. 329-346.
- McGowan, D. (2005). "Legal Aspects of Free and Open Source Software", in Feller et al. (2005) above, pp. 361-390.
- Meyer, M. H., Lopez, L. (1995). "Technology strategy in a software products company", *J. Product Innovation Management*, Vol. 12, No. 4, pp. 194-306.
- Meyer, M. H., Seliger, R. (1998). "Product Platforms in Software Development", *MIT Sloan Management Review*, Fall 1998, pp. 61-74.
- Nambisan, S. (2001). "Why Service Businesses are not Product Businesses", *MIT Sloan Management Review*, Summer 2001, Vol. 42, No. 4; ABI/INFORM Global, pp. 72-80.
- O'Mahony, S. (2003). "Guarding the commons: how community managed software projects protect their work", *Research Policy*, Vol. 32, 2003, pp. 1179-1198.
- Osterloh, M., Kuster, B., Rota, S. (2002). "Trust and commerce in Open Source—a contradiction?" MIT Working Paper.
- Osterloh, M., Rota, S. (2007). "Open Source Software Development—Just Another Case of Collective Invention?", *Research Policy*, Vol. 36, 2007, pp. 157-171.
- Pykäläinen T. (2006). "Model for Profiting from Software Innovations in the New Era in Computing", *Technovation*, 2006, doi:10.1016/j.technovation.2006.11.005. In press.
- Rajala, R., Rossi, M., Tuunainen V. K., Korri, S. (2001). *Software Business Models. A Framework for Analyzing Software Industry*. TEKES Technology Review 108/2001.
- Rossi, C., Bonaccorsi A. (2005). "Why profit-oriented companies enter the OS field? Intrinsic vs. extrinsic incentives", *Fifth Workshop on Open Source Software Engineering (5-WOSSE)* May 17, 2005, St Louis, MO, USA, 2005, ACM 1-59593-127-9.
- Russo, B., Braghin, B., Gasperi, P., Sillitti, A. and Succi, G. (2005). "Defining TCO for the Transition to Open Source Systems," in *Proceedings of First International Conference on Open Source (OSS2005)*, Scotto, M. and Succi, G. (eds.), Genoa, Italy, July 11-15, 2005, pp. 108-112.
- Shapiro C., Varian H. (1998). *Information Rules*. Harvard Business School Press. Boston, MA, USA, 1998.
- Simon E. (1996). "Innovation and intellectual property protection: The software industry perspective", *Columbia J. World Bus.*, Vol. 31, No. 1, pp 30-37.
- Szczepanska A. M., Bergquist M., Ljungberg J. (2005). "High Noon at OS Corral: Duels and Shoot-Outs in Open Source Discourse", in Feller et al. (2005) above, pp. 431-446.
- Teece D.J. (1986). "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy", *Research Policy* 15, 1986. Pp. 285–305.
- Thomke S., von Hippel E. (2002). "Customers as innovators—a new way to create value", *Harvard Business Review*, Vol. 80, No. 4, April 2002, pp. 74-81.
- Välimäki, M. (2005). *The Rise of Open Source Licensing. A Challenge to the Use of Intellectual Property in the Software Industry*, Turre Publishing, Helsinki, 2005.
<http://lib.tkk.fi/Diss/2005/isbn9529187793/>

The Laptop as Alibi

Tomas Lindroth
University West, Sweden
tomas.lindroth@hv.se

Abstract. The increased use of mobile technology in everyday life changes the behavior in well-known situations. This article reports from an ethnographic study of laptop use, more specifically it focuses on three findings from the student's everyday life where the laptop is present; the private screen, Online Tics and Screen Saver fear. Goffman's different views of involvement are used to conduct an analysis of the findings. The analysis shows how the different forms of involvement, which the laptop enables, also favors external contacts and activities, which had not been tolerated without the mediation of the laptop. Further, the analysis tells us something about the role the laptop takes in use. The connection between the laptop and work, the students' strive to always be connected and the related online tics that the laptop triggers support the role of the laptop as an Alibi.

Keywords. Use, ethnography, university, laptop, Goffman

Introduction

The adoption and diffusion of mobile technologies in to almost every situation of our society changes certain aspects of situations we ones thought we knew. When mobile phones, mobile music players, PDA:s and laptops enters situations such as dressing rooms (Weilenmann, 2003), trains (Lindroth, 2001), meeting- and classrooms (Fisher et al.,2004) there is aspects of the technology use that would be helpful to know more about in order to deal with the new technology enriched/diluted situations. Taking a photo in the dressing room of yourself in what might be your next suit and sending it to your spouse for pros and cons opens up for interesting services. Or, consider the teenagers playing their newly downloaded song aloud for the whole train compartment, many people find that

irritating. While I like to see these different uses of the modern mobile IT as new, they are merely replacing old technologies and habits. Before the mobile phone camera was available, maybe you would never have gone to the store by your self, without your personal clothes critiques, thus the phone only replaces an existing behaviour? Or the very popular cassette recorder from the 80th carried on the shoulder by longhaired hard rockers, how is that different from the mp3-players with loud speakers of today? The cliché “everything changes, nothing is new” comes to mind. This article deals with the consequences of students carrying their portable technology where ever they go and how that, at first sight, changes their behavior. Imagine the student on the third row sitting with the evening newspaper neatly placed in his nee reading page three of the British newspaper *The Sun*. It has certainly happened in classrooms where the students have not been equipped with laptops, but where they are equipped, it happens everyday. This article investigates the role of the laptop that makes such behaviors possible, in a university setting.

The material on laptop use presented here is part of a larger ethnographic study that has been ongoing since 2003. The extended time period and the relative stable context that a university and a laptop offer have been an excellent environment to study. It has ensured that the studied phenomena are not directly related to an adoption phase, a trend or other ephemeral phenomena. It has offered extensive possibilities to talk about and observe use from a quite close and participative perspective. The observed persons have all been master students at the university, and they have all had their own laptop. The portable technology brought by the student between home, the university and other places forced me to re-focus from snapshots of use in one setting to the process of use that spans both social and physical places as well as temporal borders. However, looking at the research on mobile IT, it tends to focus on quite specific situations. Research on IT-use can be accused of emphasizing isolated problems without looking at whole practices (as seen in Luff & Heath, 1998; Fagrell, 2000; Lundin, 2005; Ratner et al., 2001). We fail to see technology as something brought into an interaction process and the consequences of use over extended periods of time. But through this long term study it has been possible to build up a picture of the laptop in use that tells us something about the role the laptop takes. The ethnographic account has been analysed using Goffmans involvement analysis as well as his Typologies of participation. Goffmans theories on everyday interaction was chosen due to his already established vocabulary and description of everyday life as well as a tool to get to the fine grained details of everyday interaction. The result of the analysis of these details reveals how the laptop in use vouch for the student in different situations and in that sense takes the role as an Alibi. Certain aspects of the situations and the technology act as amplifiers of this role which will be discuss in detail further on.

The next section introduces Goffmans view of Involvements which is in turn followed by an extensive part dealing with the methodological issues of ethnography. Then accounts from the ethnography are presented that includes excerpts from observations and interviews. The analysis following this, connects Goffmans theoretical notions with the empirical material. The article is ended with a discussion about the different aspects of the laptops role as an Alibi.

Goffman on Involvements

Dominant side-involvements

The empirical findings presented in this article are all based on observations of the fine grained interaction in the students' everyday use of the laptop computer. Erving Goffman have developed his Interaction analysis in relation to talk and public behavior and does not deal with the use of technology at all, still I find his work valuable when analyzing the micro interaction of the empirical material. The notions of Goffman's work that will be used in the analysis of the empirical material are used in order to develop the role, of the laptop in use, as an alibi. The level of involvement in a certain activity may according to Goffman vary, here I will specifically deal with different levels of involvements and especially "dominant side-involvements" (Goffman, 1963 p45). Since this study takes place at a university it is convenient to take an example from a similar setting in order to exemplify what is meant by dominant side-involvements. Imagine a lecture, the lecturer is standing in front of the class giving his talk about a certain subject, the lecture is here the main involvement. The students in the class room may listen more or less concentrated over time. While concentrating on the lecture, a student may still be drawing doodles in a notebook without being regarded as somebody who is not focused on the lecture. Such an involvement of drawing is a sub-involvement according to Goffman. It is an involvement that may not interfere with the main involvement and that is something that we can do at the same time as something else. Chewing gum is another example. Similar to the sub-involvement but different in nature is the side-involvement. It is an involvement that a student may do in parallel to the main involvement and that often have relation to the main-involvement, i.e. the lecture, such as taking notes. The problem, during a lecture, is when a side-involvement takes over and becomes the dominant involvement for a particular student.

Away

Loosing one self into cyberspace during a lecture was not on the menu in the 1960s when Goffman wrote his *Behavior in Public Places*. But still, loosing one self into imaginary worlds was an option:

“While outwardly participating in an activity within a social situation, an individual can allow his attention to turn from what he and everyone else considers the real or serious world, and give himself up for a time to a play like world in which he alone participates” (Goffman, 1963. p 69)

Entering an imaginary world during a lecture is maybe more common than one as a lecturer wants to admit. But still, the student may demonstrate her absence from the scene in various ways including the faraway gaze or by other side involvements such as picking ones nose or humming, behaviours that are quite easily observed if one wants to see them. But still this is a con game, getting away with going away involves strategies to conceal it from the others involved in the gathering which in this study directly involves the laptop. Dealing with awayness, from the lecturer’s point of view, becomes an even more important issue when there is a risk of amplifying the behaviour through the use of laptops.

Substitute Companion and Minimal Main Involvement

In certain situations such as at the central station waiting for the train or while eating alone at a fast food restaurant the main involvement is not enough in order to make the person feel at ease. The main involvement at the central station is waiting or travelling and at the fast food restaurant it is eating. But it is cumbersome to look involved while waiting and not totally accepted to be too involved in eating. Goffman offers the notion of substitute companion as an explanation to the common habit of bringing a newspaper while eating alone. The newspaper becomes the side involvement that the eater may divide her attention to while finishing her meal. Consequently, while waiting in a lobby, at the central station or while travelling the main involvement may not be enough. There for, these places are often filled with free newspapers and magazines that may be interpreted as an offering of a minimal main involvement making the person waiting less strained and more at ease with the situation. When the waiting is over this minimal main involvement may be quickly disregarded and a focus towards the “real” main involvement is established.

Involvement shields

Sometimes we do not want to get involved with others at all, still there are very few places where one may be truly alone. The bathroom is one example of where an individual may be guaranteed to be alone since it is possible to lock the door. In other situations it is not possible to stay out of involvements with others, at work, the movies, parties etc are situations where you meet other people and involvements are unavoidable. Then the only solution is to refrain from entering it at all. Another solution is to conceal improper involvement and give the impression of proper ones. Goffman writes about this as Involvement Shields, barriers of perception that hinder other participants to notice what is going on “behind the scenes”.

“Involvement shields, behind which individuals can safely do the kind of things that ordinarily result in negative sanctions.” (Goffman, 1963. p 39)

These shields may be physical as headphones but may also be geographical like a garden at a party where a newfound couple may enter to make out. Goffman also reports on portable involvement shields though they are no longer in use. Referencing Turner’s “A History of Courting” (1954) he draws parallels to women’s use of fans while in public presence. While fans during the 18th century were officially to protect from the sun they were also used to conceal flirting, blushing and gazing that was not considered appropriate for a woman.

Research approach of everyday laptop use

Methodology

The study applies ethnographic methods, or in other words, an ethnographic perspective on empirical material. In this interpretative, subjective tradition the researcher is in a very real way part of the data (Van Maanen, 1988; Clifford & Marcus, 1986). Data is not merely collected; rather it is generated as part of the researchers’ involvements in the practice. As this research focuses on understanding relations to technology and interactions among people, involving oneself and interacting with the students is of great importance. This engagement with practitioners involves an aspect of responsibility and of seeing oneself as accountable for the results presented. Not only does the production of ethnographic accounts demand both training and changing perspectives (as suggested by Forsythe, 1999) but it also demands insight into the impact of one’s own work. Ethnography is always about taking a stand, “Whether explicitly or

not, representations either serve or undermine the dominant ideological structures sustaining existing societal structures. On this view, ethnography should be reconceived as a contribution either to cultural critique or cultural hegemony” (Anderson, 1997, p. 8).

Understanding the role as an important subjects in the ethnography I must provide some background, as well as discuss my relation to the studied practice. The studied practice is that of being students at the university. The author has during periods acted as teachers, and examiners to some of the students, something that obviously affects the relations between researchers and students. The first author has been conducting the fieldwork as part of a larger project on mobile IT use. This study has been going on during three years studying mobile IT-users in trains, buses, and in school. The presented excerpts are taken from the written field notes of the first author and from interviews of students. The observations were conducted in two main settings: (i) in the open shared areas at the university as well as (ii) during lectures. In the open areas of the university the observations were generally conducted covertly, in the sense that the students were not informed that they were studied. However, the observations were conducted in public places at the university, where the researcher has access to the same "data" as any other participant within that setting. The students on the other hand are aware of being in a public place and that what they do, say, i.e. everything they do in that setting is accessible to other people in that setting. This is an important aspect which limits potential ethical problems of studying people without them being aware of it. The classroom studies were conducted as the fauthor taught the students over a ten-week period. During this time students were observed from this perspective. Something that was valuable to get a close view of the students group work. As a supervisor the researcher could be a part of the everyday work of the students, getting access to details that would not be observable anonymously in public places. During the time as a teacher twenty students was interviewed. The interviews are based on McCracken's (1989) open ended interviews which are semi-structured and may be seen as a discussion between the interviewer and the interviewee compared to a more formal and structured interview. The interviews were tape recorded and transcribed verbatim.

Introduction to the empirical setting

As mentioned the study is conducted among students at a university department. The department is rather young and the educational programs given are mainly master programs, all with an orientation towards IT. The department was started to support new multidisciplinary research and educations. Not only were the educational programs new, but it was also focus on "new" ways of teaching, new infrastructure for learning, new ways of examination, industry involvement in the

education, etc. The localities are modern, with designer furniture, places for short ad hoc meetings, group work rooms. The teachers, administrators and students eat lunch in the same rooms, faculty is not physically located away from teaching areas etc. When you enter the floor where the university is located you enter a café like area with small tables and chairs, water and coffee machines. The open areas are next to group rooms and more traditional classrooms. Lunchrooms, coffee machines, printers and the open areas are shared between staff and the students.



Picture 1: A common study arrangement at the university

All the students at the university are to have a laptop for conducting their studies. This is economically supported through a leasing deal which all students are offered. This means that most students lease a laptop during their time at the department, normally one and a half years. The laptops are equipped with a wireless LAN capabilities and the whole building of the department, there is Wireless networks available. This means that the department has no computer labs. Instead, the students collaborate in the café-like milieu, much like in Picture 1.

During lectures students commonly bring their laptops along. They have them opened and turned on, hardly anyone of them take written notes during lectures or at seminars. As they are also constantly connected opens up for written interaction among students in the classroom, as well as WWW access during classes in general. The avid use of computers in class is something that some lecturers find threatening and frustrating, while some considers it a resource in their lectures.

Result

In the following section I will first give an overview of a students daily life. This is followed by three empirical findings; The private Screen, Online Tics and Screen Saver fear, these findings will be described individually. The Result section will end with a compound analysis connecting the theoretical handles with the empirical result.

The following empirical text will show examples of different aspects in the students daily life.

A common observation at the university is students sitting in small groups working on joint projects. Either in the open areas or in dedicated group rooms. Observations of such a situation shows, as one may expect, a range of more or less parallel activities with different purposes. Quite often I observed, which is also confirmed in interviews, IM-messaging between students sitting around the same table. But just as common is chat-sessions with others that are not co-present. IM-sessions are mixed with face to face conversations, programming, writing of reports etc. In parallel with face to face talk I often observed what the student them selves termed bore surfing. Bore surfing may be exemplified by surfing mp3-players, clothes or for the tenth time that day visit the www.digg.com. These intermingled activities can be observed any other day at the university.

At the end of the day the students close the lid of the laptop and puts it down in their rug sack together with books and papers. The trip home looks different for the different students depending on where they live. Well at home most of the students have a broadband connection also at home, something that has increased during the study (ranging from 0, 5 Mbit-25Mbit). WLAN, IP-telephony and other broadband services are utilised but not to a great extent. The everyday relation with the laptop at home is at some levels different from school but not as much as one could expect. In interviews students state that they have adjusted there MSN and ICQ so as to auto start ones they are online which makes them available for quite the same interaction possibilities as at school. Bore-surfing is just as common in the home as it is in the school. In situations where the student have a family, the laptop is less utilized, but still, sitting with the laptop in the knee surfing in front of the TV is common.

During daytime while at home, time that may be compared with work time for the student, the work continues in a similar fashion compared to a day at school. The same IM-contacts, address book, documents history, URL-history are available. The same software's are installed and configured in the same way and the

documents are open when the students open the laptop in the morning. The student's interaction history is available in different ways and forms within the laptop.

The purpose of the descriptive account above is presented in order to give an overview of the process talked about in the introduction.

The private screen

During observations it have been observed how the students sitting around a table are shifting their laptops slightly to-and-fro in order to keep the other group members eyes of the screen. But only slightly so that there should be a possibility to lean over for the person sitting nearby and view the screen. Sharing and the ability to let other people see their screens is an important feature of group work and during lectures. Even other lecturers have been observed with this behaviour in class, especially during seminars where more than one lecturer is present. Also in interviews with students' this behaviour have been confirmed. That one is not totally comfortable that someone else is looking at the screen. In the following excerpt from an interview with four students in a group room at the university, this is expressed in a slightly different way. When we enter the interview they discuss the micro mobility and the shareability of the laptop:

R3: You don't even need to lean over. If you want the others attention you send him an ICQ and then he just shifts his gaze towards my screen at the same time that I position the screen slightly towards him.

R1: You may do that at stationary computers as well but it's much longer [distance] in computer labs.

R4: Absolutely, an example of this happened at a lecture we had a couple of weeks ago. It was so boring, and then there were this new game, something with penguins'. At the end of the lecture the whole class was playing, on started and...

R3: Except Mario that was looking at Jack Ass instead

R4 :If you got an icq-message and the lecture was boring, you followed the link that was often present in the message. And then you look around yourself and see that everyone is surfing.

There are two aspects from the excerpt above that I want to put forward. How students, when they want to, share what is on their screens and how easily this is done both in the classroom and other situations. It is important to note that the

visibility of one screen towards other students are often sensitive even if the observer is another student. And the second aspect is the amplifying effect of the IT. Comparing this with the old phenomena of sending paper notes in the classroom which is between two students. When the laptop is the medium, it easily involves the whole class in a very short time.

Online tics

Later in the interview the following answer is given to the question on how the laptop has changed their behavior:

R3: I feel that even now when I have had it for such a long time on lectures, I still drift away into cyberspace too easily. So now I don't open the laptop so often. Because when I turn it on I suddenly turn towards my usual sites, more or less consciously, and then you are lost in cyberspace again. At the same time, the days are long, after 3 to 4 hours of seminars it feels good to do it once in a while, you can't really be concentrated for that long...Its both positive and negative. But you need to have that switch yourself, that when you lose your self too much it is time to put it down.

This more or less conscious behavior it's brought up in almost every interview that I have conducted. It is also something that happens at home, during group work and during lectures. One student tells me that some times, while at home in the evening, he finds himself in front of the computer, without knowing why he is there. When he tries to remember why he is in front of the computer, he remembers that it was something that he wanted to check on the net, but when he opens the lid of the laptop, it automatically turned from hibernation and displayed the open window of his web browser. As showed in picture 2, it opened, displaying the "Links menu" or "Quick links menu" where he had put the links that he surfs several times a day. Out of habit these links were followed to see if anything new had happened. When he was finished with these quick links, he had forgotten why he started to surf in the first place. I call this behavior Online Tics or web-tics, that is, certain auto behaviors that are triggered in relation to surfing the web.



Picture 2: The "Link Menu"

These tics may be triggered while being in front of the computer or when the subject is watching TV, doing the dishes etc. While there are cognitive aspects of Online tics I only cover the empirical, observational part. The students' own explanation of this behavior when confronted with it is their wish to "feel online" and "being up to date".

Screen-saver fear

Over the years I have seen this phenomenon both in observations and during interviews. A student is sitting in front of her laptop doing nothing, or noting that is possible to observe. When the screen saver starts, she touches the mouse or other tracking device instantaneously. When the screen saver disappears, she goes back to doing nothing. The same thing has been observed during interviews where I always ask the student to bring their laptop. While we are talking about something and the screen saver starts, the student is there, making it go away. In most of these situations our talk has not been directed towards the laptop, i.e the laptop has not been part of the discussion at that time. When students are confronted with this behavior they partly give the same explanation as they did in relation towards Online Tics, to "feel online" but additionally, the screen saver makes them feel like not working or not as efficient as they would otherwise.

Analysis

The dominant involvement during a lecture is the lecture it self. To follow what is said and be part of any existing discussion etc, to be part of what the other students sees as the main involvement. Side involvements may be to scribble in ones note book or taking notes for later use where one reflects what over what is said. When the laptop is present, the student may take notes on the laptop. She may look up things on the net that is discussed and visit different pages and use certain software's that have a relation towards the main involvement. But then, there is a risk that the student's online tics take over and the student is lost surfing web pages that have no relation towards the main involvement. The side involvement becomes the dominant involvement for that particular student. This change of footing happens when the student change the focus from the lecture towards an activity with a different purpose then the main involvement. She has lost focus of the lecture but still, in the studied setting her behavior is accepted by other students as well as by the lecturer. Why is it OK to read a newspaper on the screen but not while it is printed on paper? Well, one reason is that as long it does not disturb the other students' involvement, the side involvement may be accepted even if it is observed. The online tics example presented in the home situation of

one of the student is a different example of the same phenomena. The online tics in this situation are not competing with such a strict main involvement, but the example demonstrates the strength of the tics and the attraction of the media capabilities of the laptop, capabilities that are very hard to compete with as a lecturer.

Goffman's term away is here related towards situations such as the one described above where the student is being away with the laptop, lost into parallel reality. But also that the student get away with her side involvements that in other situations would not have been accepted. Getting away is a strategy that is visible in the private screen observation. It shows the students awareness of and the deliberate choice to keep the screen clear from curious eyes, not only to do things that are not appropriate in the lecture setting, but to have the choice to do so. It is certainly an issue of privacy as well, if one can avoid others to observe ones screen most people would probably do so even if the activities on the screen were related towards the main involvement. Still they have the possibility and strive towards the ability to share the content on their screen when they want to.

The students talk about the laptop as work and for most of them they also think of somebody in front of a laptop as somebody working. It has gone so far that they regard time in front of the laptop as work time, no matter what they really are doing. While there is some truth to this, both students and lecturers are well aware of the double edge of the laptop. While it is an excellent tool for work, it is also a resource for great entertainment. My interpretation is that the laptop has become the minimal main involvement during group work and work at home. It is OK to stay home a day or two from school as long as you are connected and online. In the open areas at the university as well as at places such as the central station the laptop also becomes the substitute companion. No other involvements beside the laptop are necessary both for the student using the laptop as well for present others, since the laptop is primarily related to work. It is a legitimate involvement in these settings. Also, it becomes the shield between the involvements that the student chooses to engage in and the ones they are not. If parts of a lecture deals with already well known areas, a student may during this part, choose to engage in other activities. The question one has to ask here if this is considered an appropriate behavior? Since there is a risk, as presented in the empirical part as the amplifying effect, that the behavior spread to other students that are not as familiar with the subject. The portable involvement shield that the student bring from home to school and other places, is a great resource and tool in order to legitimate certain behaviors that other wise would have been regarded as improper.

The screen saver fear relates to most of what is written above. It says a lot of how the students perceive the laptop and the role it takes. As soon as the screen saver goes on, the magic is lost, no appropriate minimal main involvement, no substitute companion and no involvement shield. When the screen saver goes on, the laptops relation towards work is lost. That is how the students perceive it anyway and that is the important part, other students in the open areas are not likely to take notice of a screen saver. Rather, it changes how the student see themselves in the situation, without the laptop there is no one there that vouch for them, that legitimize their presence.

The laptop as alibi

The laptop enables and opens up activities that would in certain circumstances not be accepted, there fore I suggest the role of the laptop as an alibi. With the laptop as a companion the students can get away with certain behaviors such as reading a newspaper during a lecture.

The laptops connection to work is the key to the alibi. Other words comes to mind, the kitchen apron or the role of the chaperon would also work as roles. Goffman is clear about that it is not what you actually do that is important, it is how you feel and the signals that you transmit that matters when it comes to involvement. It is a matter of inward feeling and outward expression. As long as the student perceives that others perceives them as working the spell is not broken. Still, everybody is aware of the laptop possibilities. The problem is that as long that the content on the screen is not available to the public, the present others cannot be sure if the person is working or not. A semi transparent screen would change the laptop behavior dramatically.

That a lecture is an arena of different frames of involvement is nothing new. For as long as there have been lectures there have been students dozing off, doodling etc. The laptop is not the creator of such a phenomena but maybe the initiator and it may well be the amplifier of it. There is a social phenomena during lectures that is about a change of footing ones in a while, you listen, loose concentration and find your way back. But it is argued that the laptop amplifies this behavior. With the portable laptop, the involvement shield, comes the online tics that are supported by the accompanying bookmarks and quick links ready to be utilized. There is an increased risk that the student won't find her way back on her own. And there is an increased risk that the dominant side-involvement will become more and more accepted. A popular reaction is to blame the technology if it is misused (e.g. The VCR), or if that is not possible, to refocus and instead try to cure the user (e.g. RoadRage (Michels, 2000)). The question is not, as I see it, if

one should ban laptops from lectures, or cure the student from inappropriate behavior but rather how one can foster a positive utilization of the laptops from an organizational point of view. That is, the universities have a responsibility to focus on how to foster the students into rational laptopers, rather than only blaming the technology or the user.

The laptop has many positive effects, both in school and at home, that is not covered in this article. In order to deal with the problematic effects that I do cover, there are a range of different measures one may take. One may ask where these “problems” of laptoping lies and what we should treat in order to cure or foster a positive mobile learning experience? Do we treat, the organisation, the user or the technology and when we have decided what or who to treat, what does the treatment look like?

Another natural follow up on these findings could be implications for design or some other form of design suggestions on how to utilise this role of the laptop in a fruitful way. For instance, how to use RSS, feeds or podcast in order to always be prepared when one needs that substitute companion.

Conclusion

Social conducts in public places have not changed as much as one could expect at first sight. The technology equipped students use the laptop in ways similar to that of other artifacts studied over 40 years ago. The laptop acts as a challenger of the socially accepted main involvement. Its characteristics as a substitute companion and involvement shield make it the perfect alibi for a dominant sub-involvement. More research is needed in order to better understand the double edged sword of the laptop, both from a learning as well as a coagent perspective.

References

- Anderson, R.J. (1997). Work Ethnography and System Design. *The Encyclopedia of MicroComputers 20*, A. Kent and J.G. Williams (eds.), Marcel Dekker, pp.159-183.
- Clifford, J. & Marcus, G.E. (eds.) (1986). *Writing Culture: The Poetics and Politics of Ethnography*, University of California Press.
- Fagrell, H. (2003). NewsMate: Providing Timely Knowledge to Mobile and Distributed News Journalists. *Beyond Knowledge Management: Managing Expertise*, M. Ackerman et al.
- Fisher, L Keenan, P Butler, N. (2004) *International Conference on Informatics Education Research*, Washington.

- Forsythe, D.E. (1999). "It's Just a Matter of Common Sense": Ethnography as Invisible Work, *Computer Supported Cooperative Work* 8, pp.127-145.
- Goffman, E. (1963). *Behavior in Public Places*. Free Press, New York.
- Hammersley, M. and Atkinson, P. (1995) *Ethnography*, Routledge, London.
- Luff, P. and Heath, C. (1998). *Mobility in Collaboration*. In *Proceedings of the ACM 1998 Conference on Computer Supported Cooperative Work*, edited by S. Poltrock and J. Grudin, ACM Press, pp. 305-314.
- Lundin, J. (2005). *Talking about work – Designing information technology for learning in interaction*. Doctoral thesis. Informatics. Göteborg.
- McCracken, G. (1989). *The Long Interview*. Newbury Park, CA: SAGE Publications, Inc.
- Ratner, D., Reiher, P., Popek, G., Kuenning, G. (2001). *Replication Requirements in Mobile Environments*. *Mobile Networks and Applications* 6, 525-533. Kluwer, the Netherlands.
- Schulze, U. (2000), *A confessional Account of an Ethnography about Knowledge Work*, *MIS Quarterly* 24(1).
- Van Maanen, J. [1988], *Tales of the Field. On Writing Ethnography*, University of Chicago Press.
- Weilenmann, A. (2003). *Doing Mobility*. Doctoral dissertation, Department of Informatics, Gothenburg University, Sweden
- Wiberg, M. (2001). *In Between Mobile Meetings: Exploring Seamless Ongoing Interaction Support for Mobile CSCW*, PhD Dissertation, Umeå University, Sweden.

Mapping service quality – comparing quality of experience and quality of service for Internet-based map services

Sara Eriksén, Charlott Eliasson, Markus Fiedler, Stefan Chevul and Annelie Ekelin

Blekinge Institute of Technology, Sweden
{first name.last name}@bth.se

Abstract. In this paper, we present an on-going research project in which we are focusing on examining how users of map-based services on-line experience the quality of these services when the traffic load is high, and how the users' experiences of acceptable or not acceptable quality can be related to measurable parameters which can be used to manage network traffic and improve technical solutions. The project is a multi- and interdisciplinary project in co-operation between researchers within human work science and informatics, and researchers within telecommunication systems. Additionally, there are two external partners in the project: a provider of Internet-based map services, and a municipality which uses this provider's map services regularly. One of the main methodological issues addressed in the project is how laboratory based, quantitative research methods from research on Quality of Service in the telecommunication systems area can be related to qualitative research methods focusing on workplace- or other live-world based use situations and Quality of Experience as defined by users of the services. How can experiments and studies be designed, and results shared, such that both network traffic measuring and evaluation of user experiences retain their own paradigmatic validity and relevance, while fruitfully informing service design?

Keywords. Quality of Service, Quality of Experience, Key Performance Indicators, Use-oriented Design, Service Design

Introduction

During the past few years, the tendency towards convergence between different forms of information and communication technologies has become increasingly evident. Today, most new mobile phones are designed not only for voice communication but also for sending and receiving text messages and multimedia, and for accessing interactive services offered via the Internet. The Internet has changed the way people, governments and businesses work and operate. Internet-based services are becoming more and more interactive and more and more elaborate. However, different network solutions, variations in network traffic load, as well as the design of different network services and various security measures can make huge differences in individual instances of service performance. Thus, *Quality of Service* (QoS) has become an important issue for service providers as well as for users. Service design, security aspects, network performance issues, as well as the users' perspective, such as user requirements, are all factors of the QoS model, as pointed out by Gustafsson and Fiedler (2004). However, the focus is gradually shifting from what used to be mainly the provider's perspective, primarily highlighting network traffic management issues, to more deliberately including a user's perspective of delivered services, as evidenced by the now frequent use of the broader concept *Quality of Experience* (QoE). This puts new demands on multi- and interdisciplinary research and development in order to cover the broad spectrum of issues relating to QoE and in order to develop new models for understanding how these different aspects interrelate, and what this may imply for service design and service management as well as for research methods and models.

In this paper, we present an on-going research project, *Mapping Service Quality*, in which we are focusing on examining how users of map-based services on-line experience the quality of these services when the traffic load is high, and how the users' experiences of acceptable or not acceptable quality can be related to measurable parameters which can be used to manage network traffic and improve technical solutions. Security measures and how they affect response time are one of several aspects which are being considered in this context. We chose to study map-based services because they are becoming increasingly common and popular. At the same time, they are usually complex, are often used in time- and safety-critical situations and thus put high demands on service performance.

The *Mapping Service Quality* project is a multi- and interdisciplinary pilot project which is being funded during 2007 by the Internet Infrastructure Foundation (.se). It is being carried out in co-operation between researchers within human work science and informatics, and researchers within telecommunication systems. Besides the researchers from different research groups within the same university, there are two external partners in the project: a provider of Internet-based map services (hereafter referred to as the Map Service

Provider), and a municipality which uses this provider's Internet-based map services regularly (hereafter referred to as the Municipality).

One of the main methodological issues addressed in the project is how laboratory based, quantitative research methods from research on QoS in the telecommunication systems area can be related to qualitative research methods focusing on workplace- or other live-world based use situations and QoE as defined by users of the services. How can experiments and studies be designed, and results shared, such that both network traffic measuring and evaluation of user experiences retain their own paradigmatic validity and relevance, while fruitfully informing service design?

In the following, the telecommunication researchers present the suggested design of a test bed for laboratory based experiments focusing on user experience of varying response time. This test bed design has been jointly agreed upon by all the involved researchers. However, it is mainly focused on QoS and a rather narrow perspective of QoE, even if it allows for a certain amount of "situatedness" of the user, mainly perceived as different levels of stress which can be artificially induced during the experiments.

After this, the human work science and informatics researchers present how they propose to enhance these laboratory based experiments with ethnographic studies focusing on how professional users of map-based services within the Municipality work with these services today and how they perceive the experimental environment set up at the University and the tasks they are assigned to carry out in the laboratory tasks in relation to their actual everyday use of map-based services. The challenge here is currently perceived to be how to bring this rich and mainly qualitative empirical material from "the field" to bear on the quantitative results from the laboratory experiments. Might it have implications for the future design of the next series of laboratory experiments? Might the results from the laboratory experiments have implications for the future design of a follow-up field study? How might our different methods and models merge, if at all?

Key Performance Indicator "Response Time"

Map services belong to the category of interactive services, *cf.* Fiedler *et al.* (2005). From the perspective of a user, an interactive service should display the desired result as quickly as possible after the user has issued the request. Fast response is an important part of what the user considers as good QoE. We define the *Response Time* (RT) as the elapsed time between when a user requests information and when the information is received and displayed by the application. The probability that the response time of the application is less than or equal to a *threshold* t , $\Pr\{RT \leq t\}$, is the main performance parameter, also called *Key Performance Indicator* (KPI). For instance, a service might be

considered to work sufficiently well if $\Pr\{RT \leq 4 \text{ s}\} = 95\%$, i.e. if the chance that the response time does not exceed four seconds is 95%. This type of specified service level objective is usually part of a *Service Level Agreement (SLA)*, such as telecommunication providers have been negotiating with their customers since the 1980:s. Measuring service quality within telecommunication systems research has traditionally mainly been focused on measuring QoS parameters such as the blocking ratio of calls, independently of actual user perceptions and use situations. In the Internet context, performance measurements were for a long time not considered to be important. They were mostly left to the end users, providers etc., who have had to perform round-trip time measurements and their interpretations on their own account. However, during recent years, the focus has gradually shifted to include user experience of central parameters such as response time.

Several studies have investigated the willingness of users to wait for web-based information, *cf.* Bhatti (2000), Bouch (2000), Rajamony (2001) and Zona (1999). Based on this and Nielsen (1994), Fiedler (2004, 2005) summarises reported thresholds in user perception as follows:

- $t > 100 \text{ ms}$: the user notices that the system is not reacting instantaneously;
- $t > 1 \text{ s}$: the user's flow of thought is interrupted;
- $t > 4 \text{ s}$: the user gets bored;
- $t > 10 \text{ s}$: the user's attention is lost.

A study by Hewlett-Packard, *cf.* Bouch (2000), revealed user reactions to artificial delays in a realistic web shop scenario. Upon perceiving latencies, the users quickly became uncertain and reluctant when dealing with monetary transactions (“If it’s slow I won’t give my credit card number.”). A gradual appearance of a delayed web page was preferred, rather than having to wait for the content to be displayed all at once (“As long as you see things coming up it’s not nearly as bad as just sitting there waiting and again you don’t know whether you’re stuck”). Users particularly welcomed being informed about problems (“I think it’s great...saying we are unusually busy, there may be some delays, you might want to visit later. You’ve told me now. If I decide to go ahead, that’s my choice.”).

Users perceive response times through the situation in which they find themselves. A “relaxed” user usually has more patience than someone in a stressful situation (e.g. finishing work, knowing you will have to run to catch the bus; making an important decision when being forced to do so quickly, etc.). The more “stressed” the user, the lower the threshold t becomes, i.e. the more critical a high QoE becomes. Thus, due to the shifting focus from measuring data transfer within a technological network to measuring user experience, use conditions and situations, i.e. *user stress*, need to be taken in to account. This reduces the KPI and affects the fulfillment of the SLA term $\Pr\{RT \leq t\}$.

The response time itself is influenced by the ICT system, consisting of applications (clients; servers; peers) and networks (devices; links). Any kind of disturbance in the ICT system may cause increases of the response times. Examples of such disturbances are

- competing processes or performance limitations at the client and server side (e.g. in the terminal hardware and software), yielding delays in sending and receiving data
- network-level perturbations such as situations of overload and/or resource limitations on network links and within network equipment, yielding loss and delay when transferring data. Data loss entails extra delays because of necessary data retransmissions. Such perturbations are typically considered to be QoS problems

The end user perceives the response time at the end of a supply chain, i.e. each entity along the path between client and server application might add additional delays. The more and worse the QoS problems, the longer the user-perceived response time becomes. It gets closer to, or even crosses, the threshold t more frequently, which means a reduction of the user's QoE perception. Such *network stress*, in other words QoS problems, stress the demands on the SLA term $\Pr\{RT \leq t\}$ as well. Obviously, the combination of user and network stress can easily lead to a service level which is much too low compared to the SLA. The goal of this work, from the telecommunication systems researchers' perspective, is to quantify these effects and to establish context-dependent relationships between QoS and QoE.

Experiments

In order to quantify service levels and QoE as functions of response times (reflecting network conditions and QoS) and related thresholds (reflecting user conditions), laboratory-based experiments involving real users will be carried out. These users will be asked to carry out tasks, for which the response time is measured at different entities along the service supply chain. Also, the user reactions will be measured and subsequently correlated with the response time.

User tasks and conditions

In each test case, the user will be given the same tasks to complete. The same tasks will be assigned in order to make it possible to compare the result, RT, in all the test cases. If the tasks were different, for example involving varying size of the requested data, this would result in varying RT for the test cases even if the test case conditions in all other aspects were identical.

The first task given to the users will be to retrieve a specific map. The second task will be to retrieve further information in the map by clicking a specific symbol on the map. These tasks will be performed both in sequence and separately. Each task will result in a RT. When performing the tasks in sequence, there will be two different RT:s to measure, one for each task. This sequential-tasks case will also include the time it takes the user to analyze the map between the two tasks, resulting in a total time for the test case, consisting of the sum of two RT:s and one AT (Analysis Time).

The participants in these test cases will be professional map service users, employed in the Technical department of the Municipality. They will perform predefined tasks in the laboratory-based test application, and the situation and context will vary for different test cases.

- There will be a basic test case where the user situation is relaxed and there is no specific context. These user conditions will be considered as good.
- Subsequently, the user might be stressed by the context in which the tasks have to be performed, e.g. by urging a decision to be made based on the results from the map handling.

Additionally, the varying network conditions described in the following are intended to contribute to simulating problematic conditions and stressful situations in real life use of map services.

Network conditions

During the experiments, the conditions of the network will be varied by deliberately influencing the data transmission capabilities. In the first test case, the network QoS will not be affected by any disturbances, i.e. the network conditions will be good. The subsequent test-cases will involve imposing different disturbances on the stream of packets carrying the application data of interest. Such QoS disturbances will include

- Packet loss according to given ratios;
- Packet delays, following different distributions;
- Throughput constraints.

The larger these impacts, the worse the network conditions, the worse the QoS and the worse the QoE. The bad network conditions will be created using a *shaper*, having the possibility to take a controlled impact on the QoS, e.g. by throwing packets according a given loss ratio or by increasing the spacing between packets order to emulate a certain limitation of transmission speed.

As described by Fiedler *et al.* (2005), security affects the QoS through increased processing times and additional overhead. The impact of security on the

QoS must be studied from a user's point of view in order to see how security affects the QoE, although this will be subject of future work.

Measurement setup

The end-to-end response time will be measured at the user end, at the client. The request and response will be logged and compared to get the response time. This includes delays from the whole system.

There will be several taps in the network. These taps eavesdrop on the traffic and logs when a packet passes it. Figure 1 shows a possible setup. The user issues the request on her/his terminal (arrow 0), which is captured by the measurement point M1. The terminal passes on the request via the network towards the server, thereby passing the network-level measurement point M2. The request is processed by the server and the response is passed on to the client (arrow 2) at the user's site, which then displays the result (arrow 3). It is worth noting that the response time at the server is in general smaller than the response time at the client, i.e. $RT(M2) < RT(M1)$. The user, sitting at the end of the supply chain, perceives the worst response time throughout the whole chain. The difference between $RT(M1)$ and $RT(M2)$ illustrates the impact of the network in-between and its QoS.

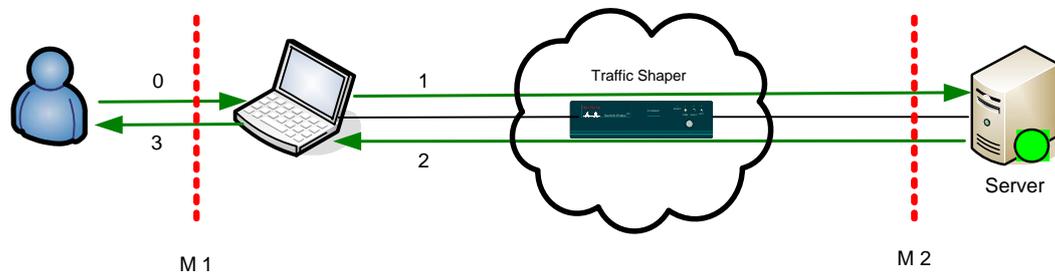


Figure 1. Illustration of measurement points (M1 and M2) for response times.

Test cases and setup

During the experiment period of this project, several test scenarios will be designed and performed. Each test scenario will have a specific hoped-for result parameter that will be considered during design to make sure that we actually measure what we have set out to measure.

The test cases will be divided into smaller areas such as User and Network, where the conditions can be of different levels of good or bad. There will be scenarios where all conditions are good, where all conditions are bad and also

where the conditions for User and Network are good and bad respectively and the other way around.

The conditions for User and Network have direct impact on the RT and also indirect impact, in the form of perception of the RT. If the User conditions are bad, e.g. in form of stress, then the user will have less patience with variations of the RT. A value that in a relaxed situation is considered to be a normal and accepted RT will, in a stressed situation, perhaps not be acceptable for this specific user. The Network conditions on the other hand, that have a direct impact on the RT, will increase with the worsening of the conditions. This can then lead to values of the RT that will not be acceptable for this specific user.

If a further discussion of these two points of view is held, it can be seen that they are almost each others inverse. When the user has bad conditions his /her threshold for RT values is low, and when the network has bad conditions it results in a high value of the RT. In the case where both network and user conditions are bad, the network will provide a higher RT and the user has lower thresholds than in normal conditions, which will not “converge”.

For testing the system used by the Map Service Provider, a mirror will be made in an experimental environment at the University. The mirrored system will then be expanded with a traffic shaper and measurements point.

When the equipment is running properly, it will be moved to a real-life environment at the Municipality. All the experiments will then be performed there, with real-life conditions and professional users.

The field workers' perspective

If the above is seen as the telecommunication systems researchers' approach, which is mainly quantitative and experiment based, then what follows below may be seen as an explorative and qualitative approach brought to the *Mapping Service Quality* project by the researchers from human work science and informatics. This approach involves starting out with ethnographic field studies among professional users of map-based services, who are employed within the Technical department of the Municipality. During early autumn 2007, we will be carrying out open-ended interviews and workplace observations with users in order to gain insight in to how, and in what situations, these services are used today, and how they are perceived by the users. The interviewees will also be invited to join a user group for future reference and for taking part in laboratory based tests.

Exploring QoE in situated use of map-based services

In the research area of informatics, there is an on-going shift of focus from systems to services (Dahlbom 2002, Hultgren 2007). QoS is regarded as a complex and multi-layered concept with shifting definition depending on the context. It can be understood as both a support system requirement and a high level requirement (Östlund 2007), though it is often treated as either one or the other, and the two are seldom focused simultaneously and in relation to each other. Similarly, but even more so, QoE in e-service research within the area of informatics is usually understood as complex, multi-dimensional and situated. In a recent review of research on e-service, Rowely summarizes her findings by arguing that it is necessary to go beyond studies of e-service quality dimensions and also take into account the inherent characteristics of e-service delivery and the factors that differentiate one service experience from another, in order to understand e-service experiences (Rowely 2006).

In this article, we do not have the ambition to go further in presenting current theories within the area of e-service, or even to attempt to define more precisely the concepts of QoS and QoE. Ours is a social constructionist and pragmatic approach, in which our primary aim is to explore the meanings of these concepts as they are construed and perceived in everyday work practice and in telecommunication systems engineering research practice, respectively, and thereafter to relate these understandings to each other and to research and methods concerning e-service design and management. Our ethnomethodologically informed, ethnographic approach to studying, in this case, QoE as it is perceived in situated use of map-based services by municipal employees (who are professional and experienced users of these services), is a research approach that we have developed over a number of years of studying use and design of e-services in the public sector (Dittrich *et al.* 2002, Eriksén 2002a, Eriksén 2002b, Dittrich *et al.* 2003). It is strongly influenced and informed by the Scandinavian tradition of participatory design as well as by ethnomethodological understandings of design-in-use of IT (Suchman 1994, Dittrich *et al.* 2002).

So what is new in this case? In the project *Mapping Service Quality*, we are attempting to unpack what is, from our perspective, the “black box” of telecommunication systems. Our ambition is to seriously and extensively relate engineering understandings of QoS and QoE to user experiences of e-service quality in use. In order to challenge our own assumptions, and stretch further across disciplinary boundaries, we are, in this project, tentatively exploring the concept of *contextual engineering* as a way of talking about our aim to merge and rework methods and models for measuring and exploring QoS and QoE from telecommunication systems research on the one hand and informatics and human work science research on the other hand. We are not sure how far, or quite where, this will get us, but we feel, as action researchers involved in a number of on-

going, technology-driven R&D projects, that we need to seriously address the fact that we are located in, and taking action from within, the School of Engineering, at a technical university, which is explicitly profiled towards designing, developing, managing and understanding applied and emerging technologies.

Discussion

In the introduction, we posed the question “*How can experiments and studies be designed, and results shared, such that both network traffic measuring and evaluation of user experiences retain their own paradigmatic validity and relevance, while fruitfully informing service design?*” This article is a first step in articulating part of a multi- and interdisciplinary dialogue which we need to continue and get deeper into, in order to achieve what we are aiming for in the project *Mapping Service Quality* – a merging and reworking of methods and models for measuring and exploring QoS, QoE and for service research and design. It is obvious, to the reader as well as to us, that we are writing from two very different research perspectives, and that, as yet, we have not been able to develop and present a shared framework, other than the general framework of the project itself. Problematizing the measuring of t in the SLA term $\Pr\{RT \leq t\}$, and contextualizing it relative to situated use and user perceptions of QoE, is a challenging beginning. However, a large part of the potential quality of this project, as we see it, lies in the active involvement of the Mapping Service Provider and the Municipality (in this case the customer/users). Together, they provide a practice-based touchstone for our theory-building, which we need to develop methods to make good use of. This practice-based knowledge and experience, we believe, will become more visible as we get further in to the project.

Conclusion

As we are still in the initial stages of both the multi- and interdisciplinary project *Mapping Service Quality* and the multi- and interdisciplinary dialogue around QoS, QoE and the emerging (at least for us) concept of contextual engineering, we feel it is too early to draw any serious conclusions. Let it suffice that we have raised, and hopefully also provoked, one or two serious questions across disciplinary boundaries.

References

Bhatti, N., Bouch, A. and Kuchinsky, A. (2000), Integrating user-perceived quality into web server design. In *Proceedings of WWW'00*, Amsterdam, 2000.

- Bouch, A., Kuchinsky, A., and Bhatti, N. (2000). Quality is in the eye of the beholder: Meeting user's requirements for internet quality of service. Technical Report HPL-2000-4, HP Laboratories Palo Alto, January 2000.
- Dahlbom, B. (2002). From *Systems to Services*. Internet document available at <http://www.viktoria.se/~dahlbom/>
- Dittrich, Y., Eriksén, S. and Hansson, C. (2002). PD in the Wild; Evolving practices of Design in Use. In *Proceedings of the PDC 2002*.
- Dittrich, Y., Ekelin, A., Elovaara, P. Eriksén, S. and Hansson, C. (2003). Making e-government happen. Everyday co-development of services, citizenship and technology. In *Proceedings of the 36st Hawaii International Conference on System Sciences - 2003*.
- Eriksén, S. (2002a). Localizing Self on the Internet; Designing for "Genius Loci" in a global context. In Dittrich, Y., Floyd C. and Klischewski, R. [eds.] (2002), *Social Thinking – Software Practice*. MIT Press.
- Eriksén, S. Designing for Accountability. In *Proceedings of NordiCHI*, Århus, Denmark 2002.
- Gustafsson, K., and Fiedler, M. (2004), "E-government: services, needs and user satisfaction". Report, Blekinge Institute of Technology. February 2004. Available at www.bth.se/fou
- Fiedler, M. (ed.) (2004). "EuroNGI Deliverable D.WP.JRA.6.1.1: State-of-the art with regards to user-perceived Quality of Service and quality feedback". May 2004. Available at <http://www.eurongi.org>.
- Fiedler, M. (ed.) (2005). "EuroNGI Deliverable D.JRA.6.1.2: Studies of user-perceived Quality of Service within EuroNGI". Jan. 2005. Available at <http://www.eurongi.org>.
- Fiedler, M., Chevul, S., Isaksson, L., Lindberg, P., and Karlsson, J. (2005). "Generic Communication Requirements of ITS-Related Mobile Services as Basis for Seamless Communications", *Proc. of the First EuroNGI Conference on Traffic Engineering*. Rome, Italy
- Gleeson, B., Lin, A., Heinanen, J., Armitage, G., Malis A. (2000). RFC2764 *A Framework for IP Based Virtual Private Networks*
- Hultgren, G. (2007). *eTjänster som social interaktion via användning av IT-system – en praktisk teori*. [eServices as social interaction via use of IT systems – a practical theory] Dissertation. Linköping University.
- Nielsen, J. (1994). *Usability Engineering*. Morgan Kaufman, San Francisco.
- Rajamony, R. and Elnozahy, M. (2001). Measuring client-perceived response times on the www. In *3rd USENIX Symposium on Internet Technologies and Systems (USITS)*. San Francisco, March 2001.
- Rowely, J. (2006). An Analysis of the e-Service Literature: Towards a Research Agenda. *Internet Research*, Vol. 16, No. 3, 2006, pp.339-359.
- Suchman, L. (1994), Working relations of Technology Production and Use. In *Computer Supported Cooperative Work*, Vol.2, p 21-39, Kluwer Academic Publishers, Netherlands
- Zona Research Inc. (1999). The economic impacts of unacceptable web-site download speeds. April 1999
- Östlund, L. (2007). *Information in use – in- and outsourcing aspects of digital services*. Dissertation. Blekinge Institute of Technology.

Advertising in Ubiquitous Media Environments

Carina Ihlström Eriksson, Maria Åkesson and Jesper Hakeröd
School of Information Science, Computer and Electrical Engineering, Halmstad University
{carina.ihstrom_eriksson; maria.akesson; jesper.hakerod}@ide.hh.se

Abstract. This paper address advertising in ubiquitous media environments by empirically discussing challenges suggested in previous research. We have performed 15 interviews, 4 workshops and 3 brainstorming sessions with publishers and advertisers. Our findings agree with previous research but also point out several additional challenging issues. We conclude by suggesting that the publishers are well suited to take on the role as pervasive service providers and identify four specific challenges related to that role: 1) How to develop models to produce and make use of consumer information dynamically over time in a ubiquitous media environment?; 2) How to adjust advertising to consumer preferences, i.e. advertising on consumer terms?; 3) In what ways can advertising be integrated with services/content adjusted to context? and 4) How to create an arena for building relations between consumers and advertisers as well as between advertisers?

Keywords. Ubiquitous media environment, advertising, challenges.

Introduction

Advertising is the most important revenue stream for media houses along with circulation fees. The ongoing convergence of technology and media (Lyytinen & Yoo, 2002) and changed media use patterns have influenced publishing at media houses, resulting in a ubiquitous media environment for publishing (Åkesson & Ihlström, 2006). Most media houses today publish in multiple channels, existing in a multitude of infrastructural environments, such as print, online, telecom and broadcasting etc. Moreover, they publish news around the clock available

anywhere and anytime in public places, homes as well as in individual pockets. Indeed, this ubiquitous media environment creates opportunities for new and innovative ways to advertise.

The ongoing trend of digitalization is of vital strategic importance for the media houses since they lately have experienced decreased circulation and advertisement revenues for their printed editions (The Economist, August 26, 2006), thereby being forced to find complementing revenue sources. The online banner sales has taken off during the last years, mostly benefiting the larger media houses with banner sales from well known brands, while smaller regional or local media companies still struggle to find their way into this market. However, mobile news services have not taken off as expected, they still only attract a small audience (Åkesson & Ihlström, 2007), and without a mass audience it is hard to attract advertisers to the mobile media (Ihlström, 2005).

Now, the media houses are on the doorstep of yet another digital media mobile innovation, the e-newspaper, i.e. a newspaper service published on e-paper technology, which has the potential of becoming very interesting for both publishers and advertisers. The e-paper technology is reflecting, giving the same reader experience as paper, such as high contrast (with 170 dpi) and the possibility to read in sunlight. Further, it is light weighted, thin and non-sensitive. Moreover, the e-paper device is uniquely identifiable making it is easier to target individuals with advertising. These benefits provide new opportunities for publishing mobile news services that provide both a quality reading experience and have the possibility of target audiences. The e-newspaper holds the potential of combining the readability and overview from the printed newspaper with the possibilities of online media such as constant updates, interactivity and video (Ihlström *et al.*, 2004). It is even predicted that the e-newspaper may replace the printed edition in the long run (Ihlström, 2005). As stated above, media houses are dependent on two customers, i.e. readers and advertisers to cover their cost of production and distribution. The potential replacement of the printed newspaper with the e-newspaper would dramatically reduce production and distribution costs for the media houses, making it an interesting prospect for the industry. However, to make this a reality it is of utmost importance to attract the advertisers to this new channel.

In the European DigiNews project we have paid attention to the production, distribution and consumption of the future e-newspaper. We have studied the perspectives of different stakeholders, e.g. publishers, readers and advertisers. In this paper we focus on publishers and advertisers view of advertising in ubiquitous media environments in general and in the e-newspaper in particular. The aim of this paper is to add to existing literature on advertising in ubiquitous information environments by empirically discussing challenges for ubiquitous advertising.

Theoretical Background

Constant development and introduction of new mobile technology, converging IT and media as well as integrated global infrastructures are trends that has led to a ubiquitous information environment. Ubiquitous information environments is a term describing services offered in a multitude of devices delivered in integrated infrastructures in mass scale (Lyytinen & Yoo, 2002). This ongoing development influence the emergence of new channels for media content (Lyytinen & Yoo, 2002). In the media sector, this has lead to the publishers of today are organized as media-houses publishing in a multiple channels such as print, online, telecom and broadcasting, i.e. in an ubiquitous media environment (Åkesson & Ihlström, 2006). In this environment, advertising in mobile channels, such as the e-newspaper, is an important part of the business.

Mobile advertising or m-advertising has lately attracted researchers interest. For studying m-advertisement Salo and Tähtinen (2005) suggest a framework (see Figure 1) that describe influencing factors relating to mobil media and consumers goals in using a mobile devices. They state that advertising in mobile media should differ from traditional advertising since that is related to targeting groups. As mobile media is more personal, advertising in mobile media benefits from being targeted at individuals rather than on target groups, even though this might require permission in some countries. For the consumers to give permission, advertisements need to meet their requirements.

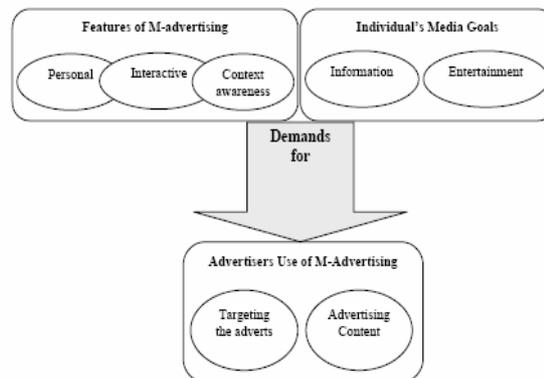


Figure 1. The factors influencing the success of m-advertising (Salo & Tähtinen, 2005, p. 4)

As can be seen in Figure 1, m-advertising is personal, interactive and context related fitting with the consumers individual media goals, thereby putting demands on advertiser decisions about advert targeting and content. To make use of the fact that mobile devices are highly personal, together with the possibilities of contextual adaptation and thereby targeted advertising content and interactivity, are expected to add value to advertisers. This means that the right individuals will be targeted, at the right time and place with matched advertising

content on which the targeted individual can react, creates a more intimate relation, closer to a personal meeting (Ranganathan & Campbell, 2004).

In a study aiming at determining the key influencing factors for m-advertisement value, content characteristics, frequency of exposure, and consumer characteristics (see Figure 2) were explored (Haghirian *et al.*, 2005).

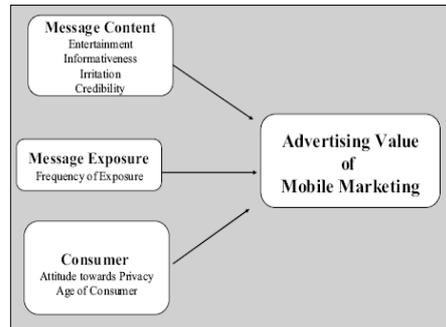


Figure 2. Advertising Value Model for Mobile Advertising (Haghirian *et al.*, 2005, p. 4)

The study showed that perceived value is strongly related to the content and frequency of the advertisement. The consumer profile, such as age, proved to be of less importance for how advertising value is perceived.

Another study, by Xu and Teo (2005) indicate that consumers have more expectations on entertainment value than on information value of mobile advertisement. Further, this study suggests that privacy issues are important for acceptance of mobile advertisement.

Two elements in m-advertising were identified by Komulainen *et al.* (2006), i.e. the mobile channel and the content of an ad, in a study addressing consumers as well as advertisers. Their findings are summarized in Figure 3 below.

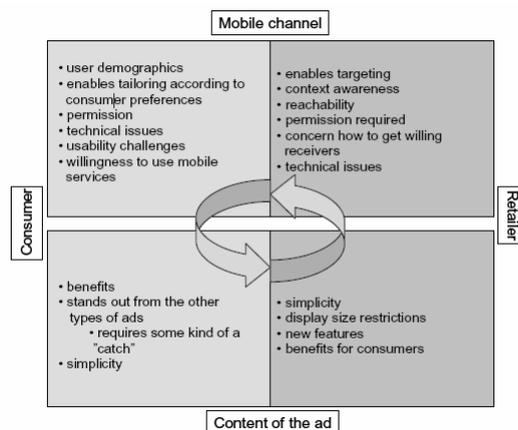


Figure 3. Relation between mobile media and ad content (Komulainen *et al.*, 2006, p. 6)

From the consumer perspective, the mobile channel offers tailoring possibilities of advertisement according to individual preferences. Consumer demographics, usability and technical issues, and willingness to use mobile services have influence on m-commerce.

Ranganathan and Campbell (2002) discuss the challenges in pervasive computing environments to be related to the intimacy with the consumers. In this paper we do not differ between the terms pervasive and ubiquitous environments. Advertising in such environments allow targeting of consumers, timing of delivery of ads in suitable ways. This offers new opportunity to advertising but it is also challenging to balance the interests of the consumers with the interests of the advertisers. Ranganathan and Campbell (2002) outline seven issues to address for advertising in pervasive environments:

- Reaching the right people with the right ads
- Delivering ads at the right time
- Delivering ads in the best way
- Serendipitous advertising
- Providing a means for users to follow up on the ad
- How should advertising revenue be collected in a pervasive environment?
- Privacy and Security

The first challenge is to match consumer needs with advertiser offerings and the second is about delivering ads at the consumer's convenience. The third regards how to deliver the ad given the decided target group and timing. The fourth challenge deals with how to catch the interest of people that did not know of for example a product. The fifth relates to the consumers possibility to react on an ad to get more information or to buy the product or service, but also to indicate that they do not wish to receive any more ads from that company. The sixth challenge is about what models that are suitable for collecting advertising revenue, for example by number of clicks in an interactive environment or number of times an ad is shown. Finally, the seventh challenge is about how to balance the need for personal information and privacy as well as security issues.

In their visioning Ranganathan and Campbell (2002) suggest solutions that may overcome these challenges. They discuss how a pervasive service provider, i.e. a service provider reaching a variety of locations (e.g. homes, offices, parks, cities) in a variety of ways (e.g. computers, billboards, TV, mobile phones), containing commerce, payment services, advertising services etc. In this paper we are arguing that newspaper publishers could take such a role in the future as they are intensely deploying their presence in ubiquitous media environments and new ways of providing services and doing business. In the following the suggested solutions to the seven challenges is described and compared to related literature.

For overcoming these challenges a middleware solution is discussed, with capability to transform different data formats to be suitable on the device it is going to be presented on. If this is supported, new types of ads can be developed making use of several interfaces and formats (e.g. sound, video, touch panels etc.).

The right people can be targeted by consumers indicating their preferences, requesting or prioritizing ads, which also have been pointed out by Salo and Tähtinen, (2005). This can also be done based on behavior, for example based on what people are buying. Detection of behavior such as staying late at the office, could render ads on late night food delivery. In short, this is about discovering consumer's intent. Tailoring ads is one way of getting closer to users (Komulainen *et al.*, 2006).

Based on context information, the best possible time and way to deliver an ad can be determined. Such context information may be based on location, time of day, the company of the consumer, the consumers schedule etc. Context awareness is an important part of m-advertising (Salo and Tähtinen, 2005; Komulainen *et al.*, 2006).

The best is to reach the consumer when free enough to follow up on the ad, still not too annoying for the consumer. It is important that there is a fit with the consumer's individual goals (Salo and Tähtinen, 2005).

In this environment, serendipitous ads could fit well with peripheral displays that people walk by or elevators etc. Adapting message content (Haghirian, *et al.*, 2005) and catching content of ads (Komulainen *et al.*, 2006) help create serendipitous ads in ubiquitous information environments.

There needs to be a good interface for consumers to follow up on an ad, e.g. to request for more information, for personal contact or even for buying the product at hand, independently of how or when they were reached by the ad. Interactivity is part of a successful m-advertising model (Salo and Tähtinen, 2005). This includes being able to react negatively on an ad.

The advertising model described is pushing ads to the consumer and therefore privacy is very critical issue. Information about how and when an individual was reached should not be revealed to the advertiser from the pervasive service provider. Further consumers should be able to decide if and how much advertising they are willing to receive. A service provider should collect consumers permissions (Salo and Tähtinen, 2005; Komulainen *et al.*, 2006). For example, a consumer or group of consumers may want to block ads on certain times or in certain situations.

In this kind of environment, advertisers could not be guaranteed time or space for their ads. Consequently, collecting revenues for ads is a bit tricky. The authors picture several criteria for advertising fees e.g. consumer request, guesses of interest, serendipity, kind of media and format. Consumer's willingness and when

and where they want to be reachable for advertising content can be other alternatives (Komulainen *et al.*, 2006).

These challenges and solutions in a pervasive information environment by Ranganathan and Campbell (2002) are related to concepts in the models described above. In Table 1, a summary of these relations is presented.

Challenges described by Ranganathan and Campbell (2002)	Suggested solutions by Ranganathan and Campbell (2002)	Related concepts from other studies
Reaching the right people with the right ads	Platform for transformation of formats Discover user intent (based on interest and behavior)	Targeting (Salo & Tähtinen, 2005) Tailoring (Komulainen <i>et al.</i> , 2006)
Delivering ads at the right time	When users are free enough to act on an ad (based on context information)	Fit with individual media goals (Salo & Tähtinen, 2005) Context awareness (Salo & Tähtinen, 2005; Komulainen <i>et al.</i> , 2006) Message exposure (Haghirian <i>et al.</i> , 2005)
Delivering ads in the right way	Where the user is going (based on context information)	Technical issues (Komulainen <i>et al.</i> , 2006) Context awareness (Salo & Tähtinen, 2005; Komulainen <i>et al.</i> , 2006)
Serendipitous advertising	In the users surrounding (large peripheral displays, sound in the elevator etc)	Message content (Haghirian <i>et al.</i> , 2005) Ad catch (Komulainen <i>et al.</i> , 2006)
Providing a means for users to follow up on the ad	With any device, any where at any time	Interactive (Salo & Tähtinen, 2005)
How should advertising revenue be collected in a pervasive environment?	Develop new criteria for advertising fees e.g. user request, guesses of interest, serendipity, kind of media and format	Reachability (Komulainen <i>et al.</i> , 2006) Willing receivers (Komulainen <i>et al.</i> , 2006)
Privacy and Security	User discretion User control	Personal (Salo & Tähtinen, 2005) Permission (Salo & Tähtinen, 2005; Komulainen <i>et al.</i> , 2006) Consumer attitudes (Haghirian <i>et al.</i> , 2005)

Table 1. Summary of challenges, suggested solutions and related concepts

In the following, we are empirically addressing these challenges with the views of publishers and advertisers.

Method

This research took place within the DigiNews project, a two-year collaborative research project, including several major technology firms, media houses and universities across Europe, which ended mid-year 2006. The overall goal of the project was to explore research and development issues for an electronic newspaper of the future. Our part of the project was to study the design of and business models for the e-newspaper and this paper focus on advertising which is one important aspect for building a successful business model.

This research can be classified as qualitative Information Systems research (Orlikowski & Baroudi, 1991) in that it is orientated towards people's assumptions, knowledge, and experience of newspaper media. In particular, the newspaper representatives and advertisers opinions of new ways of advertising were of interest.

Different types of data collection methods have been used (see Table 2). We have interviewed 13 newspaper representatives, performed 1 workshop with 7 publisher representatives and 3 brainstorming sessions with the projects Swedish steering group (consisting of representatives from the Swedish Newspaper Publishers' Association and eight Swedish newspaper managers). Furthermore, we have performed two interviews and three workshops with advertisers.

	Interviews	Workshops	Brainstorming sessions
Publishers	13	1	3
Advertisers	2	3	-

Table 2. Data collection activities

Interviews

All publisher respondents had key functions within each media house, e.g. editor-in-chiefs, managers, or designers. These interviews covered topics related to the scope of the project, such as organization, technology, business models, advertising, new services and design, however the reporting in this paper is limited to advertising issues for ubiquitous media environments in general and in the e-newspaper in particular. The advertisers selected for interviews were obtained by recommendations from other advertisers during the workshops described below, and the aim with these two interviews was to get a clearer view of advertising market, strategies, and their view of the e-newspaper potential.

These 13 interviews with publishers were about 60-90 minutes long and followed a semi-structured interview guide, aiming at consistency between the sites and interviewees. While allowing individual perspectives to emerge, the

interview guide provided a systematic way of delimiting topics discussed in the interview (Patton, 2002). The 2 interviews with advertisers were 1 and 3 hours long and were conducted as a conversation with only a few themes regarding advertising in digital media and in e-newspaper to cover in depth. All interviews were all recorded and later transcribed by a professional audio typist.

Workshops

The advertisers selected for the workshops represented three different segments of the industry, i.e. local retailers, national retailers and well-known brands. Each workshop focused one of the segments in order to get a rich picture of issues related to advertising in ubiquitous media environments in general and in the e-newspaper particular. The Swedish Newspaper Publishers' Association helped us to arrange the workshop with advertisers from well-known brands, while two of the participating newspapers helped arranging the other two workshops. All these workshops had four participants.

We started by presenting e-paper technology and initial prototypes of e-newspapers made within the project. Thereafter we discussed the situation for the segment present in relation to print and digital media as well as the competition at hand. Thereafter we had a discussion building on themes, such as digital advertising in general, added value with and demands on the e-paper, size, day-parting, contextual advertising, personalization, interactivity etc.

The workshop with newspaper representatives was performed last. 7 representatives from 6 media houses participated and the workshop lasted 2 hours. At this stage we have found the challenges from Ranganathan and Campbells (2002) research and during this workshop all these challenges were discussed.

The workshops lasted three hours and were led by one of the authors of this paper. At each workshop another member of the research group was present to take notes and to make sure that no important subject was overseen. The workshops were all recorded and later transcribed by a professional audio typist.

Brainstorming sessions

The brainstorming sessions with the projects Swedish steering group were all conducted at the premises of the Swedish Newspaper Publishers' Association and lasted between two to three hours. One of the authors acted as moderator during these sessions. These brainstorming sessions mainly focused on discussing viable business models in digital media with a specific focus on the e-newspaper. Advertising was one of the themes covered in all sessions. The second session

started with a summarization of the first and so on. All sessions was recorded and later transcribed by a professional audio typist.

Data analysis

The transcriptions from the interviews, workshops and brainstorming sessions were carefully corrected by the authors, and were then coded and sorted according to the seven challenges described by Ranganathan and Campbell (2002) with the use of a clustering technique (Miles & Huberman, 1994). One of the authors started the initial clustering by sorting out all available input from the transcriptions into the seven challenges. Thereafter all three individually analysed each challenge separately before taking a joint discussion in order to reach consensus about relevant issues regarding each challenge. In the following chapter we present our findings according to these challenges.

Findings

In this section we present the findings in relation to each of the seven challenges by Ranganathan and Campbell (2002). We start by presenting the general findings and continue with e-newspaper specific findings under each sub-heading.

Reaching the right people with the right ads

The most central aspect related to this challenge is consumer's interest. Reaching the right people with the right ads is about consumer analysis; it is about knowing who is interested of what, also including demographical and geographical aspects. Targeting is the term most used to describe what can be achieved in a ubiquitous media environment. Knowledge about consumers is the key for targeting. One part of this challenge is to get closer to peoples sphere of interest as illustrated by this quote:

"One exiting thing nowadays is to look at communities. It's like a view into a dollhouse. It's almost like buying rink publicity in an ice hockey game. We are trying to get inside the bubble of people, into their sphere of interest." (Advertiser)

Another central aspect discussed in relation to this challenge is advertising based on consumer behavior. The respondents give the search-based advertising as an example of a successful model. This model reaches people when they are searching for something on for example Google, reaching people with what they are interested in when they are looking for it, as illustrated in the following:

"That is why the search advertising is working very well, with Google ads. You hit the one who is searching. That is targeting on users own terms." (Publisher)

The publishers in this study discuss the search based model to be a critical challenge for them. The reason given is that this model requires large traffic volumes, larger than they have. Coordinating solutions within the industry an approach that the think may help, can be seen in this quote:

“The search model requires huge volumes. Not even Aftonbladet.se has volumes enough for this. Maybe this could be a possibility if we can coordinate our efforts between the newspapers. In the future we will see more behavioral advertising. What you do decides what ads you get.” (Publisher)

Situation-based advertising is another aspect of this challenge. The respondents discuss this to be an important model that can be further developed in ubiquitous media environments. Targeting on a situation, like when you are looking for a house to buy is a well working model. Everybody wanting to buy or sell a house is interested. The mass-market model is not selective enough since it also reaches people that are not interested and thereby get annoyed as illustrated with the following quote:

“The most irritating advertisements are those that are not targeted, i.e. mass marketing and spam. Of course, it’s not fun to receive ads from Via and Pampers if you aren’t interested.” (Advertiser)

The advertisers want to “*shoot with an air gun instead of a shut gun*” to avoid this irritation and thereby being rejected. The challenge for publishers is thereby to find sustainable models for selection in ubiquitous media environments.

Regarding the e-newspaper, the personalization possibilities due to the unique ID of the devices create an increased interest from the advertisers, e.g. to only reach all readers that live in a certain area, own their houses or have small children. This is of course dependent on the consumer’s willingness to share personal information and preferences.

Delivering ads at the right time

This challenge is all about timing. While the first challenge was about who is interested – this is about when they are interested. As expressed by one of the publishers:

“That is the Google model – when the user is there – when they are searching for something – and not when we think they want it. That is to say it is on the users conditions – that is really timing!”

Ads also need to be relevant to the consumer context. For example, if an information service with integrated ads is used, the ads need to be relevant to the content, e.g. in a service about food and cooking, ads can be about food, kitchen utilities, kitchens, dining furniture, but not about drilling machines.

Relevance is also about timing, not only time of day but also about holidays and vacation times, i.e. seasoning. One of the publishers has put together a special calendar for their advertisers to give their advertisers new ideas about timing. The

calendar shows everything from Christmas to Ramadan, mother's day to world peace day etc.

Time of day is of course also relevant, e.g. ads about lunch menus are not very interesting after 2 pm. The publishers find day-parting interesting but think that it is difficult to get the advertisers to see that:

"You could for example imagine that an ad would change its appearance during the day. That one customer has bought the space for the morning hours and another for the evening hours etc. Or that the same ad changes, a morning edition, afternoon and evening edition of the ad. For example a restaurant should be able to see the value in that. But no one has ever asked for something like that. On the web for example – we should be able to use "prime-time" like in the TV-model, in print it is the way it is". (Publisher)

The advertisers found it essential to reach the right reader at the right moment and in the right mood. One advertiser that represents cosmetics and perfumes argued the importance of reaching their target group, i.e. women in a particular age and with specific interests, at the right time and in the right mood, advertising in magazines:

"It's like a reward to your self when the children have gone to bed and are sleeping. The highlight of the day. Then you have a more emotional communication and an editorial environment that fits into cosmetics. It's a completely different environment for reading when you read the morning paper at breakfast or evening paper on the way home from work." (Advertiser)

Regarding the e-newspaper the publishers agree that contextual ads, e.g. Nike on the sports section should be supported as well as the classifieds. It should also be possible to have surround session like in the New York Times where you always have ads according to your profile following you throughout the whole e-newspaper.

Delivering ads in the best way

The publishers think that this is a problematic challenge, it is about the message and its impact provided by the media. They have just learned how to work with the web and are fumbling carefully with other channels. As one publisher said:

"We are very bad at using the strengths from each channel the best way and combine them for best effect. We should be able to use the fact that we have many channels as a huge advantage. But we do not do that today."

In the best of worlds, from a publisher view, one would start with the advertiser consumer needs and customize a solution that meet this need in the best way, using all possible channels. However, the publishers think that the average advertiser customer is not ready for this, illustrated by the following quotation:

“The small local advertisers want the same space and ad week after week. It is very difficult to communicate new or alternative ideas to them, especially ads in new channels let alone with multiple channels.” (Publisher)

Nonetheless, even though the publishers have packages they find it very difficult to customize, which requires resources that they do not have. There are several reasons for this, e.g.

a) finding someone who can coordinate and make sure the customer only get one invoice. If a customer wants a multi-channel ad campaign it is important that they only meet with one salesman and not different persons for each channel.

b) modifying advertising systems that are specialized for the printed newspaper. According to the publishers there is a huge challenge in integrating systems to make them work smoothly.

c) changing they way how people in the organization think. *“This is curial and we have experienced very good investments in systems failing because we did not manage to get people to rethink. If we cannot make people think in new ways system finesse will do no good.”* (Publisher)

The advertisers agree that it depends on the message one needs to send.

“There are no specific places but depends on the message we are about to send. We try to get a way from the product thinking and more and more go towards talking about customer benefit” (Advertiser)

Even though consumers may want to avoid ads, the multi-channel approach works in the favor of the advertisers. One of the advertisers expressed:

“Nobody can avoid advertising. Then we only say: how are we going to reach this customer in another way? The company will talk to the consumers anyway. We will have to find other ways. Shore, we can try to sort and control as a consumer, but Pampers will not give up on parents of small children just because they have rejected advertising.”

According to the advertisers advertisements can be divided into three headlines: exposure, relationship and transaction. Regards to the e-newspaper it is exposure that applies, according to the publishers:

“It is exposure that applies, and then the advertisement can tell where I can get more information.”

Another possibility with the e-newspaper is to allow the consumers to only buy specific newspaper parts, e.g. the sport section, and thereby bundling advertisement with this section. In addition, subscribing to ads of special interests was discussed as an opportunity with the e-newspaper because of the unique ID of the device.

Serendipitous advertising

The publishers think this is about a certain type of advertising, like the commercial model from TV or radio. The type of advertising that sinks

unconsciously into people's minds. The challenge is to balance so it does not annoy or irritate people, to interrupt without being disturbing. As one of the publishers said:

"The key is to interrupt in a way that catches curiosity."

This type of advertising is difficult to attach to a search or behavior based advertising model according to the publishers, as people do actively choose NOT to see ads and commercials.

"It is a delicate balance between advertising and disturbance, between surprise and irritate. If people are irritated they think SPAM – that does not work." (Publisher)

On the other hand, this type of advertisement has the potential to engage consumers:

"There is much of the commercial information that in some way engages us. In that there is aha experience, which makes us respond" (Advertiser)

Some ideas about the e-newspaper regarded this type of advertisement:

"Perhaps an advertisement can be a motion snippet between two articles? But not in the middle of an article, it should not disturb the reading experience." (Publisher)

Providing a means for users to follow up on the ad

The publishers regard feedback and interactivity as important and that they are getting better at that:

"Before, it used to be an ad in the printed newspaper and a phone number. Today, big advertisers have a branding ad in the newspaper and a reference to their own web site that may be very advanced and offers a lot more than we can help them with."

Chat sessions with experts, was given as an example of how to manage this challenges with smaller advertisers. It often attracts many people, not only those with questions, there were also many just viewing.

The publishers agreed that the mobile phone is very good for this purpose as it is much more direct. But they worried about the competition of the mobile operators:

"We have to consider how not to be by passed, how do we make sure that there is a value in going through us when advertising?"

The advertisers work hard to find ways of serendipitous advertising for attracting audience. As one of the advertisers expressed:

"The extension is to use our own website to create a relationship. Customer databases, conduct a dialog, find out more, etc, and then the initial contact is just a way to catch people." (Advertiser)

The e-newspaper creates a new arena for advertisements. For example, as suggested by publishers it would be possible to create a special "room" for the

advertiser. By clicking on an ad you arrive to the advertiser room where additional information could be published, e.g. a product catalogue. In this way the reader does not leave the e-newspaper as they might do if the click on a banner on the web. This is thought of as a new way of business:

“One could also commercialize electronic paper in the way that the advertiser could have more information space and pay us more for that. My vision is that one should be able to click on a piece of clothing and be able to see it in all available colors.” (Publisher)

According to the advertisers, the e-newspaper could provide a way of “legal lying”, i.e. presenting only a mobile phone in the ad, encouraging the reader to click on it, and when clicking the reader is presented with the legal details that usually are presented in a very small size. Games or other interactivity could also be used to attract readers, which is illustrated in the following quotation:

“The ads will change due to interactive possibilities, to get direct feedback. There will be more targeted advertisements. One will know so much more about ones subscribers.” (Advertiser)

How should advertising revenue be collected in a pervasive environment?

There must be different models for different channels according to the publishers. In paper size and placement decide the price. On the web there are a few different models like size and placement, number of clicks, period of time etc. In mobile channels they are still experimenting in a trial and error phase. They find it very challenging to stitch this together over multiple channels. It is of importance to measure how many that sees an ad, how many that is interested in an ad and how many that act on it, as this is valuable information:

“We really need to develop our methods for how to measure to produce targeting and tracing information. We really need to develop such techniques for the future. This is really a huge challenge and maybe the most important one because then we can communicate what we are selling to the advertisers.”

More direct targeting of individuals will probably increase the revenues:

“I think we will charge considerably a lot more from the advertisers. They can get more information into their advertisements and eventually even get in a motion picture. Then you can use customer databases and direct more and get more out of the advertisement for those who really want it. You can use all 18-year old in Mjölby, who shop at JC. They don't need to buy jeans advertisement to a 97-year old. They just pay for the effect. Today they shoot with a shot-gun” (Publicist)

However, this discussion has to be continued with the advertisers. This is illustrated with a quotation from one of the smaller advertisers:

"No, I have heard that about guarantees before. I don't want to know how many that has read my advertisement, I want to sell! The cash register is the best measurement."

Most advertisers and publishers agree on the importance of being able to show reach. By taking advantages of the unique ID of the e-paper device and by incorporating measurement possibilities in the e-paper device, both publishers and advertisers could benefit.

Privacy and Security

There are legislations concerning advertising which is different in different countries, but the media firms have this competence. According to the publishers privacy is much more important in the mobile channel since the devices are personal. With the printed paper a mass-audience is reached as well as online. The mobile phone is not a mass-medium, it is personal.

"You can compare it to your mailbox. It is personal and for example a SMS is sent to your individual number. But now browsing with the mobile is becoming a habit and then it is not as personal. In the browser you are in a public space." (Publisher)

Both advertisers and publishers agree that this issue needs to be addressed. Regarding the possibility of personalized ads in the e-newspaper the following quotations illustrate that it has to be on the terms of the user:

"Yes, if I have given my permission. But I don't want them to know that I'm in New York." (Advertiser – regarding offering of last minute tickets based on location)

"It's a little scary if you do not order that service by yourself. Shouldn't you be at work when the shop send a SMS when you passed by." (Publicist – regarding position based ads).

The publishers discuss that consumers may want to block advertising and consider if this should be allowed in the e-newspaper for a higher fee.

Discussion and Conclusion

The aim of this paper was to empirically discuss challenges for ubiquitous advertising. We have done that by applying the seven challenges discussed by Ranganathan and Campbell (2002) to the empirical material. We start by summarizing the findings for each challenge in Table 3. We continue by discussing what the introduction of the e-newspaper brings to advertising in ubiquitous media environment. Finally, we identify four specific challenges for the publishers acting as pervasive service providers.

Challenges	Main topics	Models
Reaching the right people with the right ads	Targeting - consumer analysis - who is interested in what	Demographic Geographic Behavioral (search) Situational
Delivering ads at the right time	Relevance - when the users want it Contextuality	Day-parting Seasoning
Delivering ads in the right way	Message Impact Contextuality	Bundling Customization
Serendipitous advertising	Balance	Interrupt but not disturb Push (scale from print to (commercials))
Providing a means for users to follow up on the ad	Feedback and interactivity	<i>Traditional</i> , such as SMS, URL, chat, phone number <i>New</i> , such as subscription, and direct sales
How should advertising revenue be collected in a pervasive environment?	Tracing	<i>Traditional</i> , such as size, place, click rate, period of time <i>New</i> , based on user behavior
Privacy and Security	Personal vs. Public sphere	Personalization on user terms Allowing blocking based on payment

Table 3. Empirical solution models for the suggested challenges

The main topics and possible models for advertising derived from the empirical material are summarized in Table 3. For the most part, the findings from the empirical activities correspond with the discussion of challenges and solutions by Ranganathan and Campbell (2002). However, in our findings there are some additional aspects that were emphasized. *First*, the challenge of analyzing consumer behavior and preferences was stressed as a prerequisite for targeted advertising. Both advertisers and publishers need to know more about the consumers and how make use of this information. *Second*, in addition to context information related to the individual consumer the empirical findings show that timing is also about cultural context. Day-parting and seasoning are two ways of adapting advertising to handle this. *Third*, the respondents underlined the importance of selecting channel or combinations of channels based on the potential impact of the advertising message. *Fourth*, to succeed with serendipitous advertising it is essential to find a balance between interrupting and disturbing as the tolerance among consumers is decreasing. *Fifth*, the publishers see the potential of taking an intermediary role, providing an interface between advertisers and consumers, thereby creating the means for feedback and interactivity. *Sixth*, the respondents stress the importance of discussing tracing related to each channel and finding ways to integrate several models for revenue collection. *Finally*, the choice of channel influence privacy issues. The

respondents remarked that some media are more personal while others are more public. It is important not to intrude the personal sphere.

We believe that the e-newspaper will add to the existing ubiquitous media environment by creating new possibilities for both content and advertising. The unique qualities of the display and device provide an interesting complement to existing channels. However, if the e-newspaper would replace the printed newspaper in the long run, the publishers need to rethink their advertising strategies.

To conclude, we argue the possibility of publishers taking the role of the “pervasive service provider”. As the publishers already today publish in multiple channels, reaching public places (e.g. information displays, in store television), peoples homes as well as individuals through their mobile phones, we believe that they have the potential and resources (competence as well as systems) to become such a provider. We believe that due to their neutrality and trustworthiness they have this potential of being accepted by both consumers and advertisers. One condition for taking this role is the ability to communicate the ubiquitous advertising model to advertising customers. Another is to gain acceptance among journalists. We have identified four specific challenges for publishers taking the pervasive service provider role:

1. *How to develop models to produce and make use of consumer information dynamically over time in a ubiquitous media environment?*
2. *How to adjust advertising to consumer preferences, i.e. advertising on consumer terms?*
3. *In what ways can advertising be integrated with services/content adjusted to context?*
4. *How to create an arena for building relations between consumers and advertisers as well as between advertisers?*

Future research will further address these challenges for taking the pervasive service provider role for advertising in ubiquitous media environments.

References

- Haghirian, P., Madlberger, M., and Tanuskova, A. (2005). Increasing Advertising Value of Mobile Marketing – An Empirical Study of Antecedents. in *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, Hawaii. (CD-ROM), Computer Society Press (10 pages).
- Ihlström, C. (2005). The e-newspaper innovation - converging print and online. In *Proceedings of the International Workshop on Innovation and Media: Managing changes in Technology, Products and Processes*, Stockholm.
- Ihlström, C., Åkesson, M. and Nordqvist, S. (2004). From Print to Web to e-paper - the challenge of designing the e-newspaper. In *Proceedings of ICCO 8th International Conference on Electronic Publishing*, ELPUB 2004, Brasilia, pp. 249-260.

- Komulainen, H, Ristola, A. and Still, J. (2006). Mobile advertising in the eyes of retailers and consumers – empirical evidence from a real life experience. Proceedings of the International Conference on Mobile Business, ICMB'06, Copenhagen, Denmark.
- Lyytinen, K. and Yoo, Y. (2002). Research Commentary: The Next Wave of Nomadic Computing. *Information Systems Research*, Vol. 13, No. 4, pp. 377-388.
- Miles, M. B., and Huberman, A. M. (1994). *Qualitative Data Analysis*. Sage Publications, Inc. California.
- Orlikowski, W. J. and Baroudi, J. J. (1991), “Studying Information Technology in Organizations: Research Approaches and Assumptions”, *Information Systems Research*, Vol. 2 No. 1, pp 1-28.
- Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods* (3 ed.). Sage Publications, Inc. California.
- Ranganathan, A., and Campbell, R. H. (2002). Advertising in a Pervasive Computing Environment. *In the Proceedings of the 2nd international workshop on Mobile commerce. ACM Press.*
- Salo, J., and Tähtinen, J. (2005). Retailer Use of Permission-Based Mobile Advertising. in Clarke III I & Flaherty TB (eds.) *Advances in Electronic Marketing*. Idea Publishing Group, PA, USA.
- Xu, H. and Teo, H. H. (2005). Privacy considerations in location-based advertising. In the *Proceedings of IFIP TC8 8.2 International Working Conference*, Cleveland, Ohio, USA.
- Åkesson, M. and Ihlström, C. (2006). Towards an Ubiquitous Media Environment - adding the e-newspaper channel. *In Proceedings of TAGA 2006*, Vancouver.
- Åkesson, M. and Ihlström Eriksson, C. (2007). The vision of ubiquitous media services: How close are we? *In Proceedings of HCI International*, Beijing.

Atelier Infrastructure for Ubiquitous Computing

Antti Juustila, Toni Räisänen

Department of Information Processing Science, University of Oulu

90014 UNIVERSITY OF OULU, Finland

antti.juustila@oulu.fi, toni.raisanen@oulu.fi

Abstract. Ubiquitous computing systems, running on distributed heterogeneous hardware and operating system platforms, need a software infrastructure hiding the complexity of the underlying hardware, software and networking technologies from the components and applications. A software infrastructure for ubiquitous computing should enable software components and applications consisting of these components to communicate over different types of networks, using different types of protocols. We describe an infrastructure called Atelier Infrastructure for ubiquitous computing, aiming at supporting the application developers in building distributed ubiquitous applications in heterogeneous hardware, operating system and programming environments. The Atelier Infrastructure addresses the abstraction, programming language independence, extendability and configurability requirements for an ubicomputing infrastructure by a message based communication and a distributed micro kernel software architectural pattern. We suggest that future research should be directed towards specifying open, common standards to enhance the interoperability of components, services and applications in ubiquitous environments.

Keywords. Ubiquitous computing, software infrastructure, distributed systems.

Introduction

Development of ubiquitous computing applications and systems face many technical and social challenges (Banavar & Bernstein 2002, Bell & Dourish 2006, Kindberg & Fox 2002, Lyytinen & Yoo 2002, Schmidt et al. 2006, etc.).

Ubiquitous computing, being still in a very early stage of development and research, presents a vision where computers are embedded in our environment, providing contextual information services and helping in organizing and mediating social interaction. Mobility, large-scale services and infrastructure and the multiplicity of different services in terms of processed and transmitted data characterize ubiquitous computing (Lyytinen & Yoo 2001).

Ubiquitous computing – implying mobility and pervasiveness of computing – requires a technological setting where computing power can be compressed into small devices and even to clothing, and also connectivity of these devices (Weiser 1993, Lyytinen & Yoo 2002). Integrating various heterogeneous computing devices, operating systems and software platforms seamlessly to minimize the complexities and coordinate the collaboration among devices and services requires a good software infrastructure (Nakajima 2003). There exists many implementations of these types of systems, based on different technologies, such as CORBA (Vinoski 1997; Gaia system, see Román et al. 2002), Java, Jini and OSGi (Nakajima 2003); or message based MVC (Qiu 2005). On mobile devices, XML-RPC and RFID tags (Salminen & Riekkilä 2005) have been used in implementing the distribution of components on top of Symbian OS, as well as HAVi (Home Audio Video Interoperability), SOAP and UPnP (Nakajima & Satoh 2006). For additional examples of ubiquitous infrastructures, see e.g. Banavar & Bernstein (2002) and Nakajima (2003).

Many technologies and standards address features that are needed in (development and use of) ubiquitous computing environments. An example of such is the device and service discovery features included in Jini as well as in Bluetooth™ (Edwards 2006). In this paper, we address mainly ubiquitous software infrastructures, not the underlying technological infrastructures. With technological infrastructures we mean existing and emerging technologies such as TCP/IP, Bluetooth™, Jini, SQL, XML, HTTP and other protocols build on HTTP, different operating systems, etc. which can be used in developing also ubiquitous infrastructures. With ubiquitous software infrastructures we mean a software platform (build on top of the aforementioned technological infrastructures) for building ubiquitous components, services and applications. The latter infrastructure should provide means for the upper level components, services and applications to be found, communicated with and used for some particular purpose in particular settings. Components and services should be configurable (Lyytinen & Yoo 2001) and by combining them to applications the needs of a particular situation should be satisfied. Since it is difficult to assume in beforehand the possible usage situations, these systems must be incrementally extensible (Nakajima 2003).

We will discuss the requirements and challenges for such infrastructures and describe one attempt to achieve an infrastructure for ubiquitous computing, the Atelier Infrastructure, developed during the Atelier IST project

(<http://atelier.k3.mah.se/home/>). After this, we will discuss the limitations of software infrastructures for ubiquitous computing and propose an additional abstraction to the software infrastructures, based on standards and message based XML languages as a framework for ubiquitous systems.

Technological challenges in ubicomputing

Ubiquitous computing systems (components, applications and/or environments) are inherently distributed and heterogeneous (Banavar & Bernstein 2002). Ubiquitous computing, aiming at making use of many different types of computers (and, effectively, computing services) available throughout the physical environment means that both the hardware and network architectures used are also heterogeneous. Especially moving devices have to adapt to the capabilities of the currently available networks, ranging from hi-speed wireless LAN connectivity to GSM data networks, or occasionally, to no connectivity whatsoever.

Adaptation is also needed in supporting the user's tasks in the changing environment. The users may need to change their goals either by external influence or by the changes in the immediate environment and the resources available there. The infrastructure must be capable of finding, adapting and delivering the necessary functionality to the user in the changing conditions. (Banavar & Bernstein 2002). In addition to adaptation, awareness of the environmental resources available and control of using the resources available are important elements of mobile computing in providing the necessary services to the users (March et al. 2000). Even though the issues of adaptation to heterogeneous content and devices have been addressed in mobile computing research, the issues of functional heterogeneity (which devices are capable of providing which kind of services and at what level of functionality) needs further research (Kindberg & Fox 2002).

Physical constraints posed by the hardware again limit the resources the applications have available: battery power is limited, size of device limits the ways of interactions with the user (Siewiorek 2002), connection speed limits the type and amount of data that can be transferred. Furthermore, different devices contain different operating systems and application programming interfaces. For application development different languages and tools are needed.

In order to make application development in ubiquitous environments easier, a software infrastructure, hiding the heterogeneous hardware, network and operating systems environments, is necessary. The following discusses some essential non-functional requirements for ubiquitous software infrastructures.

Hardware and operating system independency

The scale of different devices in ubicomp systems range from small sensors and actuators, handheld devices and smart phones to backend systems comprising of large-scale servers and database systems. Ubiquitous computing applications would have to run on multiple incompatible operating systems, from embedded real time OS's to smart phone and server OS's, and naturally be able to communicate with each other. The concept of a system or an application in ubiquitous computing is different from the usual idea of an application running on a single computer, or even from the common client-server type of a system.

Ubiquitous applications are themselves distributed over the network. The application user interface may be distributed so that a device can be used to input data or select commands, while the output is displayed on a remote display or on several mobile devices even far away. The application logic can be also spread over the network. Therefore, the application consists of several communicating components cooperating over different kinds of networks. The widely known Model-View-Controller (MVC) design pattern can be thought of being further distributed to D-MVC (Graham et al. 1996, Hansen 2005, Qiu 2005). Even further, the UI can be broken down to many individual but cooperating input and output components, implemented on different hardware and software platforms.

Network independency

Communication happens over multiple types of networks, e.g. Bluetooth™, GSM/3G, WiFi, Ethernet and near field communications (NFC), e.g. using RFID technology. For ubiquitous computing applications, this means multiple protocols that should be supported to achieve the seamless functioning of the services and applications.

The heterogeneous nature of the technologies cannot be handled without an infrastructure that hides the complexity of the underlying technologies. An infrastructure for ubiquitous computing should address the technological complexity by hiding the various communications protocols as well as the transport layer so that applications would not need to adjust to the current surrounding environment to be able to do what is expected. To some extent, of course, the applications need to be aware of their surroundings and resources available to be able to adjust the functionalities to the context at hand.

Application areas are numerous. It is difficult to design an infrastructure that fits all needs. Special purpose infrastructures may be needed in specific situations to support specialised functionalities. This may hinder the support for more generic or totally different settings than to which the infrastructure was originally planned to support. For example, a system supporting the work of physicians and nurses in hospitals requires so different types of functionalities and hardware

requirements, that an infrastructure to support the learning process of designers cannot be fitted as-is to the former type of environment.

There are different ways to address these challenges. One way to approach the problem is to build a platform or an operating system for ubiquitous computing. This kind of platform would resemble a virtual machine, since it would be necessary to be able to run it on existing operating systems. This virtual machine would act as an abstraction on top of the underlying operating system and network and additionally provide services for the ubicomp components. It would also need to either provide a programming interface for the developers, based on existing programming languages such as Java or C++, or provide a new one. Gaia (Román et al. 2002), building on CORBA and TAO (Schmidt et al. 1997), is an example of one such implementation.

Programming language independency

Infrastructures such as Gaia require a hardware platform capable of running the underlying CORBA and TAO. However, in many cases, the devices that are used are small in size and in computing resources and cannot run these types of systems. There may be the problem that the device cannot even run the compiled code or that there are no tools to compile the software for such devices. In some situations, the device cannot be programmed at all, leading to a situation where one must write an adapter component on some other attached device to be able to use the device in the system.

Extendibility and configurability

Extendibility of the system to support new requirements and features is also important. Since all scenarios of usage cannot be taken into account when designing the supportive infrastructure, one should design the system to be extendable to new features (Kindberg & Fox 2002, Nakajima 2003). Otherwise, the platform is too rigid to be used in heterogeneous environments – not only technologically heterogeneous, but also from the user requirements perspective.

Another requirement for ubiquitous systems is the question of configurability: to what extent the devices in an environment can be dynamically configured to work in different contexts. For example, a remote controller device can be used to control the presentation of media, but it could also be used to navigate other data elements and manipulate them. In research settings, this is more or less easy, requiring the intervention of a technical person, but in real life settings users should be able to change the setting and enable using the devices in the environment to be used in different contexts (Binder et al. 2004). The question is, to what extent we can proactively design the functionality of the system, or do we need tailoring for a specific purpose (Lyytinen & Yoo 2002), or is it even possible for the users and/or the system themselves to configure for a specific situation.

For example, users themselves could decide on which display to show particular media in a particular situation and be able to flexibly change this (Salminen & Riekkilä 2005).

Information formats, content

The diversity and heterogeneousness of content and information formats is a significant factor in all distributed systems (March et al. 2000). There are ontologies and standards for application specific, narrow areas based on XML, for example RDF. Usually these standards are for textual data and presenting numeric content, although some XML based standards related to multimedia exist (e.g. SMIL, for synchronized multimedia; see <http://www.w3.org/AudioVideo/>).

As ubiquitous applications and components are distributed across hardware, running on top of and communicating across heterogeneous hardware and operating systems, it is important to ensure that the content is usable in different devices, ranging from sensors and mobile phones to PDAs and other devices.

Summary

Ubicomp components and applications should be hardware, operating system and programming language independent. Furthermore, ubiquitous applications are heavily distributed, relying on input and output devices in the environment, on services residing either on mobile devices, in the surrounding immediate environment or in the background systems usually accessed through different networks. The extendibility and configurability of the environments and the support of this by the underlying software infrastructure is essential.

These are challenging requirements and there are many ways to address this problem. One can use virtual machines that are capable of running applications in many different devices. Java virtual machine is an option, with additional support by a layer of software with supporting ubiquitous computing features, such as device and service discovery. Some ubiquitous infrastructures act themselves as a virtual machine, a layer on top of an operating system. Some of these, e.g. Gaia, even work on top of many operating systems. Different protocols and standards, such as XML, can be used in implementing the software infrastructures.

The Atelier Infrastructure is one attempt to respond to the challenge. In the following, we will describe the infrastructure in detail.

The Atelier Infrastructure

The Atelier Infrastructure is a software platform where the main goal is to ease the development of applications in ubiquitous computing so that the developer of the application need not to take account the fact that the application is running in

a heterogeneous and distributed environment. The Atelier infrastructure strives to hardware, operating system and programming language independence by a messaging based solution on top of a Java Virtual Machine (JVM).

Components of the Atelier Infrastructure, forming the building blocks of a ubiquitous system, communicate over standard protocols using an XML based messaging language. The protocol architecture is extensible, thus giving room to multiple, even simultaneous use of different protocols, such as TCP/IP or JAXTA, for example. Since components communicate asynchronously using XML, the implementation language of the component is of no relevance. The developers can choose whichever programming language and tool appropriate for a certain component in the application, even though most of the components in current and past implementations have been built on top of Java and Personal Java. The most obvious benefit of using Java is the availability of the already implemented utilities, message handling code, etc., though implementations using e.g. C++ are as feasible.

As a prototype, the current implementation does not address issues related to e.g. security or quality of service, assuming secure, friendly networks with sufficient resources. These and other issues important in real life situations should be addressed in future development.

The Atelier project

The Atelier Infrastructure was originally designed and implemented during 2001-2004 in the EU funded Atelier project, a part of the Information Society Technologies (IST) program. The project was also closely related to the Disappearing Computer call.

The users in the project were students of architecture and interaction design, already passed the first 2-3 years of their studies. The aim of the project was to contribute to inspirational learning environments, which are grounded in an understanding of creative practices within design, architecture and art. The project started out from interactions between people and material artefacts in physical places and asked how we should enhance such an environment with digital technologies to turn it into a resource for inspiration and creative learning by an integrated design of learning materials, interactive technologies and architectural space.

One part of the project was to design and build a software infrastructure to support developers in building distributed ubicomp tools to support the students in their design work.

The technical goals of the project were, among others to use

...Large interactive screens, mobile phones, personal digital assistants and diverse information appliances allow us to design new augmented, flexible, and plastic and situation aware workplaces. The ATELIER project ... aims to develop and integrate these new technologies to create an augmented place for what we call 'inspirational learning' and, by doing so, to

increase our understanding of how to design systems that support more flexible and creative learning. The inspirational learning environments that we envision are dedicated physical places where people in collaboration can establish and explore a particular thematic learning space by activating, manipulating, combining and assembling configurations of representational objects of mixed media origin. Emphasis will be given particularly to learning spaces that facilitate and exploit dynamic interactions between people and objects. The environments will be open for the ad hoc introduction of new participants and new objects with associated portfolios of qualities and resources.

To support the different user scenarios of the project, the platform was designed to be extendable. As usual in a research project, the actual functional requirements were not available or were quite vague in the beginning of the project – a context of ubiquitous systems in general (Nakajima 2003). Thus the extendibility is in the core of the platform and it is implemented by following the Micro Kernel software architectural pattern (Buschmann et al. 1996), with extensions to support the distribution requirement. Micro Kernel architecture can be seen as a special type of a Layered software architecture (see Figure 1). In this architecture, the Kernel corresponds to the *device service registry* of Service Oriented Device Architecture (SODA) proposed by de Deugd et al. (2006, p. 96).

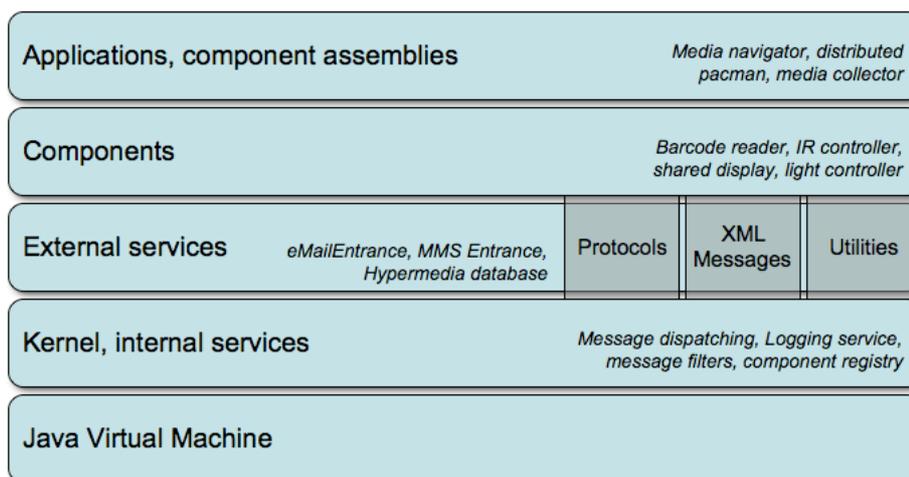


Figure 1: Architecture of the Atelier infrastructure.

A key requirement for the system was the support for dynamic configuration of the system. As different users and devices enter and exit the design space and different applications were used with the various hardware elements, it was important that the devices could be used for different purposes with different applications. For example, in one situation a device is used to select media from a hypermedia database¹ while in other situation it is used as a control device,

¹ Hypermedia database supports storing of media (images, videos) which can be hyperlinked. Also metadata on the media can be stored (e.g. location, origin, descriptions and so forth).

enabling the user to select which display should present the output from specific application logic.

Design principles of the Atelier Infrastructure

The key design principles of the Atelier Infrastructure can be summarized as follows:

- It should provide support design and implementation of distributed applications.
- The infrastructure should ease the programming of applications and components in distributed environments.
- It should provide the means to enable the independence of the components and applications from the underlying technologies.
- It should be extendable with new services and protocols.
- It must be configurable to provide support dynamic interactions between people and objects.

These key requirements were derived in the beginning of the project from the overall goals of the project, reviewing the current research on ubiquitous software infrastructures and also by looking at the various existing implementations for ubiquitous computing (e.g. Gaia). Key issues, such as flexibility, extendibility, distribution, etc. were identified. The design solutions and the implementation of the Atelier Infrastructure, based on these key issues, are discussed below.

Distributed MVC and microkernel

The platform was designed to support the division of an application to a distributed application where the different parts of the application such as view, model, and control in the Model-View-Controller (MVC) pattern communicate through a network by sending XML based messages. This distributed MVC

```
<message>
  <category name="root/registration">
    <type name="register" />
  </category>
  <body content-type="text/xml">
    <registration name="RemoteControlComponent" class="Control" type="component">
      <metainfo name="provides" type="registration" id="RegistrationProvides">
        <provides name="category" value="Root/event" />
        <provides name="type" value="input/remote" />
      </metainfo>
      <metainfo name="parameters" type="registration" id="RegistrationParameters">
        <parameter name="port" value="COM1" />
      </metainfo>
    </body>
</message>
```

Figure 2: Registration message to Kernel (simplified example).

model enables the change of the configuration of the application, i.e. change and move input or output devices from other type device to another without restarting the “application”.

Before a software component can send or receive messages to the kernel and/or other components or services, it needs to register itself to the Kernel. This is done by sending a special registration message (Figure 2), describing the type of the component and the message categories and types the component both publishes (sends to other components) and consumes (listens and reacts to when messages are passed to the component). The design follows the *Publish/Subscribe* paradigm for interaction, where components publish data and events as others consume them, supporting effectively spontaneous interaction inside the environment (Kindberg & Fox 2002, p 74).

To simplify message passing, an open message hierarchy was designed. Each message has a *category*, describing a larger group of message categories, such as registration messages, events, input data messages, output data messages, application specific messages, etc. Message *types*, describing in more detail what type of a message is, enable a finer distinction of messages inside the categories. These categories and types then are used by components in specifying of which kind of messages they register to receive, and which kinds of messages the component produces. A component can then query the Kernel if there is a component, which can consume and/or produce certain types of messages. This enhances the awareness of components of the surrounding services and other components.

Each and every Atelier component must respond to one specified category of messages – the HelloWorld message, which can be used to demonstrate the functionality of the system (the Hello world application for ubiquitous computing) as well as test that all components are connected and functioning. If the component’s meta-information (provided with the registration message) would contain location information, a component to cooperate with can also be searched and selected on the basis of where the component resides.

To support the distributed MVC model a variation of a micro kernel pattern is used which we call distributed microkernel pattern. In the distributed microkernel architecture the *Adapter* (encapsulating the intercomponent communication, corresponding to the bus adapter of SODA; see de Deugd et al. 2006), Kernel and external services are separated from each other with the Adapter proxies that hide and implement the network connection between these parts. The role of the Adapter is to abstract the communication links between the system elements, taking care of initiation of the connection as well as the data transfer and necessary manipulation of the messages before sending and/or receiving. Adapter also hides the use of different protocols from the components using the Adapter.

Ease of programming

The platform makes easier to implement distributed applications by hiding the configuration, initialization, and communications over the network under an Application Programming Interface (API).

The API consists of utility classes to manage the messages without the knowledge of XML (Figure 3), an active object handling the sending and receiving messages (the Adapter), and an event interface to be called when a receiving a message to be handled. The example code creates a notification message to other interested components that a new multimedia item has been added to the Hypermedia database, in the Media entrance hyperdocument, and includes the new media ID to the notification message.

The API is an asynchronous event based API, where sending of a message returns immediately and the reply is notified via an event from the active object to the program. The programmer registers the component to receive events when a certain type of message (or a message directly addressed to that component) arrives to the component. As the message arrives, the event is handled as an ordinary event similarly to event based GUI programming.

The application programmer does not need to generate the XML message from the scratch but there are again utility classes and methods, which marshals and demarshals the events as XML messages and converts XML messages to events.

```
public void newHyperNodeAdded(HyperNode newNode) {
    AtelierXMLMessage msg =
        new AtelierXMLMessage("application/entrance", "newitemadded");
    msg.setBodyContentType("text/xml");
    XMLElement content =
        XMLMessageFactory.getInstance().createXMLElement("node");
    Integer idOfNode = newNode.getID();
    content.putAttribute("hypernodeid", idOfNode.toString());
    msg.setBodyContent(content.toString());
    adapter.sendMessage(msg);
}
```

Figure 3: Creating a XML message with Infrastructure API.

Future enhancements include a new client API where the current client interface class is split to two parts: a client interface, which is able to communicate with adapter and a listener interface to able to register a handler for different kinds of messages. These changes allow multiple components to use the same adapter for communication, ease the message subscription, ease the application start-up, and allow lazy initialization of components. This allows flexibility of the subscriptions and is more intuitive to the programmer.

Independency from underlying technologies

To be as general platform as possible the Atelier Infrastructure was designed to use messaging as base of communication between components. The architecture can be classified as a hybrid P2P architecture (Wilson 2002) where one node (the Kernel) is a central node to hold the catalogue of addresses of other nodes (directory of services). The other role of the central node was to filter and transform the messages and subsequently route the messages to the nodes that had requested to handle the type of messages. It is also possible to create direct routes between two components to achieve greater quality of service of the communication needed i.e. transporting videos or other multimedia.

Even though the current API is implemented with Java, it is possible to create components with any programming language and to any technical platform, as long as connecting through TCP/IP is possible.

Extendibility

The extendibility of the platform rises from three factors: the extendibility of the micro kernel architecture, the extendibility of message schemas, and the support of different protocols.

To extend the platform a programmer could implement either new internal services (extensions to the Kernel, according to the Micro kernel architecture) used inside the Kernel and/or external services, which can be used from other external services and/or components and applications. Each internal service has two parts: a filter that routes the messages to the right service and the service itself. The internal services are run inside the same virtual machine as the kernel in their own threads. In the current implementation, there are three internal services: filter pipeline, name server and id factory. In future, there are plans to implement an internal service to add, configuration and remove other internal services, so that internal services could be added to the kernel at the runtime without restarting the Kernel. External services are run in their own virtual machine and/or physical device. From the Kernel's viewpoint, external services are just plain components of the system, providing general services to other components.

The second way to extend the platform is by the support of message categories and types. The header part of a message describes the category and type of the message, described above. This information is used as routing information. The categorization is the base of the publish/subscribe messaging. In addition to the categorization the header can include other meta-information, like contextual (e.g. GPS) information, for example. By defining new message categories and types, in addition to the payload of the message, it is possible to define new "languages" and data contents for specific purposes.

Thirdly, each Adapter can use a different protocol for each channel of communication Adapter has opened. The protocol could even be changed during runtime via configuration messages. The message is currently transported via vanilla TCP/IP sockets as a stream of UTF-8 characters. As a proof of concept, a JXTA (Wilson 2002) transport protocol has also been implemented. In addition, another protocol implementation is currently planned, which sends SAX or StAX events instead of sending the message as whole and then parsing the message.

Configurability

The configurability of the system is based on two factors: the publish/subscribe type of messaging and message filtering and transformation.

When a component subscribes to the Kernel, it registers the types of messages it produces and handles. Other meta-information items that components could use as registration information are e.g. screen resolution, display size, location of the device, etc. This further enhances the adaptation of the system elements to different types of hardware. In the future, the information is used to advertise the components in JXTA and/or ZeroConf/Bonjour.

To minimize the traffic, each node registers the type of messages it is able to handle. The routing component uses the registration information to route the message to the receivers. To bypass this routing and message multiplexing the sender could set the receiver of the message. This of course breaks the flexibility of the system and the use of explicit receivers is strongly discouraged. Usually the receiver is set or changed by filters to support the runtime configuration of application composition.

To meet the requirement for configurability during runtime, the central node has an internal service to support the manipulation of messages before routing to receiver(s). This filtering and transformation support enables, for example, changing the preconfigured output and/or input device as needed. Each filter is prioritized, which determines in which order the filters transform the message.

Each transformation could either stop the message routing, skip other filters and put the message directly to the outbox to be send to other components via the router, set the message back to inbox to be filtered from the start or forward the message to next filter in the change. The filter engine adds the IDs of the filters that have changed the message into the message. This information can be used by the message recipients to analyse the message, or in analysing the behaviour of the system for research purposes.

Example components and applications

In the Atelier project some prototypes utilizing the infrastructure were developed. A barcode reader and a TV remote controller were both used as input devices in the environment, acting as physical handles to digital media (Binder et al. 2004,

Loregian et al. 2006). As media (images, videos) were stored in the Hypermedia database (developed also by Oulu team in the Atelier project), the media file was assigned an ID. This ID can be printed out with a small thumbnail of the image. As users then present their designs, they can use the barcode reader and the printouts to flexibly include digital media of their presentations of the design by reading barcodes attached to physical models. Barcodes were also used as commands to handle e.g. playing of media. Certain IDs were reserved to act as commands (e.g. “play” or “stop”). Another usage of barcodes was to use them to configure the actual technical environment. Each device and application was assigned an ID, and using a barcode printout of the system components it was possible for the users to configure a “routing table”. This routing table then effectively configured the system (by using the Kernel’s filtering system) to pass the input messages from a specific input device to a software component, and the output from a software component then was also routed to an output component, usually a display.

The same functionality could be achieved using RFID tag readers and writers by inserting the id of the media file into a writable RFID tag. In both of these cases, a component was programmed into a computer attached to these devices, since the devices were not programmable. Other similar case in the project was to use an infrared television remote controller as a navigation device.

In addition to these component types of elements in the Atelier infrastructure, we also implemented External services, which provide extensions to the basic Kernel of the system. One such service is the eMailEntrance. This service has no user interface, as it is meant to be used by other components to enhance their functionality. The service helps the users to import media into the hypermedia database by simply sending email or MMS messages. The service reads periodically an email account, extracts media attachments from the message, metadata from the message headers and content, and stores these into the hypermedia database. The service also sends a broadcast message to all components registered to receive certain types of notification messages to alert the components of the new content added to the database (message creation illustrated in Figure 3).

Development plans

In the future, the central node (Kernel) is to be split into the proxies so that every node can act as a router for components that it knows about. Therefore the need of an always-available Kernel is going to be removed. This effectively transforms the infrastructure to the direction of the Pervasive server architecture proposed by Nakajima (2003) and the “infrastructure without infrastructure” (Edwards 2006) where there necessarily is not any fixed system structure (the central Kernel). In

this situation the Kernel can optionally be used as a directory server to minimize device and service discovery overhead.

We also aim to further move to support existing standards in our implementation by adhering to the OMG standard on Super Distributed Object API (Sameshima et al. 2001, Kawakami et al. 2004 & Yamamoto et al. 2004). Also we aim to add support for mobile devices by implementing the relevant parts of the system in selected mobile platforms.

The Pervasive server architecture proposed by Nakajima (2003) shares many of the development ideas we have discovered to be very useful in developing infrastructures for ubicomp systems. Nakajima, as we, propose a XML based communication between components, using simple standards and protocols for intercomponent communication, as well as discusses how components could be assembled to appliances (or applications) from separate components dynamically.

Conclusions

The infrastructures supporting ubiquitous computing should adhere to standards and support multiple protocols. An underlying, specific technical implementation should not really be relevant in developing ubiquitous applications and services. Even though we strived to use standards and aim at hardware and OS, network (protocol) independency, programming language independency and flexibility towards information formats by using XML, usually our and other existing infrastructures are still incompatible constructs among others.

In order to really reach towards ubiquitous environments, there is a need for common standards for infrastructures, applications and appliances. Research should aim to define higher levels of abstractions for ubicomputing environments. These abstractions should be based on open standards related to device and service discovery and use well known specified communication protocols. Standards and technologies such as OSGi, HTTP, UPnP, Bonjour/ZeroConf, Jini, Bluetooth, RDF, etc. should be taken as the basic elements of ubiquitous building blocks (see e.g. Nakajima 2003, Kindberg & Fox 2002, de Deugd et al. 2006, Schmidt et al. 2006, Raatikainen et al. 2002). Ubicomp services and components should use the selected standards and building blocks in implementation to ensure interoperability between implementations.

Commonly agreed upon XML based languages (again built on top of the already existing exploitable standards) should be defined, which can then be used in device and service discovery and selection and exchanging both content and evoking actions in the environment (Kindberg & Fox 2002). Instead of using proprietary message schemas in Atelier Infrastructure, we should be using open standard message schemas, thus improving the interoperability of the Atelier Infrastructure with other components, applications and infrastructures adhering to the same ubiquitous data standards (*ibid*). Specifying the message schemas should

start from the most basic features of any ubiquitous environment. For example, we specified a XML based language to be used in remotely controlling a Pac Man game and also to control a media presentation, to be used with a TV infrared remote controller and a barcode reader. Both “languages of interaction” should be defined as a standard language to be usable in a “real” (to date non-existent) ubiquitous environment.

There is also the need to specify ontologies for describing objects (both physical and computational) in a standard way. In this respect our conclusions are similar to Nakajima’s (2003). Also the environment should include a set of standard ways (protocols, ways to do device and service discovery, etc.) to find both the controllable services or components and similarly, the controllers.

Summary

Software infrastructures are necessary for building interoperable platforms for ubiquitous applications and application components. Such infrastructures should provide support design and implementation of distributed applications and ease the programming of applications and components in distributed environments. They should provide the means to enable the independence of the components and applications from the underlying technologies such as operating systems and hardware. To support various types of application areas, the platforms should be extendable with new services and protocols. Also, the configuration of the environments to provide support dynamic interactions between people and objects is essential.

There are several approaches to develop software infrastructures for ubiquitous systems. The Atelier infrastructure is based on message and event based distributed architecture, where a micro kernel acts as a router and a service repository. The communication of components and services within the infrastructure is based on XML. Using XML as the basis for the language further supports the extendibility of the system. By defining new “languages” for component interaction one can develop new functionality in the system. Implementation of components producing and consuming these messages is therefore programming language, operating system and hardware independent.

The Atelier Infrastructure is still ongoing development. Issues such as security, quality of service and performance are still to be addressed. Also, many features build in to the Infrastructure still miss the (ubiquitous) user interfaces that empower the users to really utilize the features of the system. These issues will be addressed in our future work.

Most importantly, we suggest that defining a higher abstraction layer for ubiquitous infrastructures, based on open standards and consisting of protocols, ontologies and XML based languages, should be explored, as also suggested by others. Even though these infrastructures would remain messy and complicated,

requiring continuous assembly work as suggested by Bell and Dourish (2006), developing ubiquitous environments could be much easier by agreeing on at least some common technologies to build them on.

Acknowledgments

This work has been supported by the EU funded Atelier and IPCity projects and the Academy of Finland funded Studio'n'Site project. This work is also part of the INFOTECH/INTERACT group activities in the University of Oulu, Finland. The authors were the main architects of the Atelier Infrastructure, Toni Räisänen being the main designer and implementor. We also thank the anonymous IRIS reviewers of their insightful comments.

References

- Banavar, G., Bernstein, A. (2002) *Software infrastructure and design challenges for ubiquitous computing applications*. Communications of the ACM. Volume 45, Issue 12 (December 2002). Pp 92 – 96. ACM Press New York, NY, USA. ISSN:0001-0782.
- Bell, G. and Dourish, P. (2006). *Yesterday's tomorrows: notes on ubiquitous computing's dominant vision*. Personal Ubiquitous computing. 11/2007. Pp 133-145.
- Binder, T., De Michelis, G., Gervautz, M., Jacucci, G., Matkovic, K., Psik, T., and Wagner, I. 2004. *Supporting configurability in a mixed-media environment for design students*. *Personal Ubiquitous Comput.* 8, 5 (Sep. 2004), 310-325. <http://dx.doi.org/10.1007/s00779-004-0294-7>.
- Buschmann, F., Meunier, R., Rohnert, H., Sommerlad, P., Stal, M. (1996). *Pattern-Oriented Software Architecture, Volume 1: A System of Patterns*. Wiley. ISBN: 978-0471958697.
- de Deugd, S., Carroll, R., Kelly, K. E., Millet, B. and Ricker, J (2006). *SODA: Service-Oriented Device Architecture*. Pervasive computing. July-September 2006.
- Edwards, W. K. (2006). *Discovery systems in ubiquitous computing*. Pervasive computing. April-June 2006.
- Graham, T., T. Urnes, R. Najabi (1996). *Efficient distributed implementation of semi-replicated synchronous groupware*, ACM UIST'96, Seattle, WA, 1-10, Nov. 1996. <http://citeseer.ist.psu.edu/graham96efficient.html>.
- Hansen, S. S. (2005). *Composite Device Using a Distributed MVC Architecture*. Center for Pervasive Computing. University of Aarhus. 3 May 2005. <http://www.daimi.au.dk/fileadmin/images/common/secretaries/HansenSS.pdf>
- Kawakami, J.; Sameshima, S.; Kawano, K.; Suzuki, J.; Suda, T.; Steglich, S.; Shin, S. (2004). *SDO model and its standardization activity*. Applications and the Internet Workshops, 2004. SAINT 2004 Workshops. 2004 International Symposium on, Vol., Iss., 26-30 Jan. 2004. Pages: 342- 347.
- Kindberg, T. Fox, A. (2002). *System software for ubiquitous computing*. IEEE Pervasive Computing., Volume: 1, Issue: 1. Pp: 70- 81. ISSN: 1536-1268.
- Loregian, M.; Matkovic, K.; Psik, T. (2006). *Seamless browsing of visual contents in shared learning environments*. Pervasive Computing and Communications Workshops, 2006. Proceedings of the Fourth Annual IEEE International Conference on Pervasive Computing and Communications Workshops, P. 235. March 2006. ISBN:0-7695-2520-2.

- Lyytinen, K., Yoo, Y. (2001). *The next Wave of Nomadic Computing: A Research Agenda for Information Systems Research*. Sprouts: Working Papers on Information Environments, Systems and Organizations. Vol 1, No 1 (Summer) pp. 1-20. <http://sprouts.case.edu/2001/010301.pdf>.
- Lyytinen, K., Yoo, Y (2002). *Issues and Challenges in Ubiquitous Computing*. Communications of the ACM, Vol 45, No 12. December 2002.
- March, S., Hevner, A., Ram, S. (2000). *Research Commentary: An Agenda for Information Technology Research in Heterogenous and Distributed Environments*. Information Systems Research,. Vol 11, No 4. Pp. 327-341. December 2000.
- Nakajima, T. (2003). *Pervasive Servers: A framework for creating a society of appliances*. Personal Ubiquitous Computing 7. pp. 182-188. 2003.
- Nakajima, T., Satoh, I. (2006). *A software infrastructure for supporting spontaneous and personalized interaction in home computing environments*. Personal ubiquitous computing 10/2006. Pp. 379-391. 2006.
- Raatikainen, K., Christensen, H. B., Nakajima, T. (2002). Application Requirements for Middleware for Mobile and Pervasive Systems, Mobile Computing and Communications Review, Volume 1, number 2. Pp: 16 – 24. 2002.
- Qiu, Xiaohong (2005).. *Message-based MVC Architecture for Distributed and Desktop Applications*. PhD Thesis. Graduate School of Syracuse University. May 2005. http://grids.ucs.indiana.edu/~xqiu/complete_thesis.pdf.
- Román, M., Hess, C., Cerqueira, R., Ranganathan, A., Campbell, R. H., and Nahrstedt, K. 2002. *Gaia: a middleware platform for active spaces*. SIGMOBILE Mob. Comput. Commun. Rev. 6, 4 (Oct. 2002), 65-67. DOI= <http://doi.acm.org/10.1145/643550.643558>.
- Salminen T & Riekkilä J (2005). *Lightweight middleware architecture for mobile phones*. Proc. 2005 International Conference on Pervasive Systems and Computing, Las Vegas, NE, 147-153.
- Sameshima, S.; Kawano, K.; Funabashi, M. (2001) *A trend to super distributed system and standardization activity in OMG*. Applications and the Internet Workshops, 2001. Proceedings. 2001 Symposium on, Vol., Iss., 2001 Pages:5-8.
- Schmidt, A., Spiekermann, S., Gersham, A., and Michahelles, F. (2006). *Real-world challenges of pervasive computing*. Pervasive computing. July-September 2006.
- Schmidt, D. C. Levine, D. L. and S. Mungee (1997). *The design of the TAO real-time object request broker*. Computer Communications Journal, Summer 1997. <http://citeseer.ist.psu.edu/article/schmidt97design.html>.
- Siewiorek, D. (2002). *New Frontiers of Application Design*. Communications of the ACM, Vol 45, No 12. December 2002.
- Vinoski, S. (1997). *CORBA: Integrating Diverse Applications Within Distributed Heterogeneous Environments*. IEEE Communications Magazine, vol. 14, no. 2, February 1997. <http://citeseer.ist.psu.edu/vinoski97corba.html>.
- Yamamoto, H.; Sameshima, S.; Kawano, K. (2004). *Service reconfiguration using super distributed objects (SDO) in context-aware service systems*. Software Technologies for Future Embedded and Ubiquitous Systems, 2004. Proceedings. Second IEEE Workshop on, Vol., Iss., 11-12 May 2004. Pages: 163- 165.
- Weiser, M. (1993). *Hot topics-ubiquitous computing*. Computer. Volume: 26, Issue: 10. Pp. 71-72.
- Wilson, B. J. (2002). *JXTA*. New Riders Publishing; 1st edition, June 15, 2002.. ISBN: 978-0735712348.

Exercises in Studying User Interface Design Guidelines and Patterns

Ilari Jounila

University of Oulu

ilari.jounila@oulu.fi

Mari Nikkanen

University of Oulu

marimust@mail.student.oulu.fi

Abstract. A large numbers of user interface guidelines and patterns have developed by different researchers. A multitude of different guides cause problems to find and use them effectively. This paper describes experiences and findings of a case course. As a result of an iterative development process, the set of good exercises properties for teaching user interface design guidelines and patterns are presented.

Keywords. User Interface, Guidelines, Patterns, Education

Introduction

User interface design guidelines, or guidelines for short, are a one form to convey existing usability knowledge for software developers. Also, other similar tools than guidelines exist: patterns, standards, design rules, and conventions. So far, amount of these tools has increased extensively, especially guidelines and patterns.

Guidelines could be divided for platform-independent design guidelines as well as platform-specific style guides (Henninger et al., 1995). Examples of style guides are the Apple Human Interface Guidelines (Apple, 2006) and Windows interface guidelines (Microsoft, 1995). Examples of design guidelines are the ISO 9241 standard with parts 10 to 17 (ISO 9241, 1999) and Research-based Web Design and Usability Guidelines (Koyani et al., 2006). In addition, the design patterns, such as Patterns for Effective

Interaction Design by Tidwell (Tidwell, 2006) and Interaction Design Patterns by van Welie (Welie, 2001), and also the mistakes that software developers often make (Johnson, 2000), could be included to go with design guidelines rather than style guides.

All of these artefacts included a large number of different methods, and that produce problems such as management and use of patterns (Deng et al., 2005). Other problem is generality of the guidelines, which is remarked by software designers and by usability specialists alike (Mosier & Smith, 1986). Thus, it is difficult to find which guidelines are most appropriate to a designer's specific situation (Henninger et al., 1995; Mariage et al., 2004). However, Mosier and Smith state that it is not appropriate to make more specific guidelines due to the reduced suitability to a variety of system design application (Mosier & Smith, 1986).

A quality of teaching user interface design has become increasingly an important thing. The user interface designers should learn these skills enough good so they could understand the users better. These design skills could be taught in many ways. A one way to convey design knowledge for designers is to exploit user interface design guidelines and design patterns.

Our goal was to develop good exercises for Interaction Design course. Good exercises are enjoyable and fun to do by students, and also, the exercises should provide educational experience for students. This paper describes the process of developing exercises with pedagogical patterns and design guidelines, and provides the preliminary set of good exercise properties for teaching user interface design guidelines and patterns.

Research environment

In this paper, developed exercises were part of Interaction Design course at the Department of Information Processing Science at the University of Oulu. The course is compulsory in orientation study. About seventy students participated in this first time organised course from fall 2006 to spring 2007. Because of the first time organised course, we did not have earlier produced teaching materials.

In this course, the optional lectures and compulsory exercises overlapped. Content of the course divided into two parts: *evaluation method* part and *guideline* part. Evaluation method part included existing methods such as cognitive walkthrough, keystroke-level method (KLM) and SUS questionnaire. Second part consisted of different guidelines which included user interface design standards such as ISO 9241 standard with parts 10, 12, 13, 14 and 16 (ISO 9241, 1999), user interface design guidelines such as Research-based Web Design and Usability Guidelines (Koyani et al., 2006), and interaction design patterns such as Patterns for Effective Interaction Design (Tidwell, 2006) as well as Interaction Design Patterns (van Welie, 2001).

Exercises consisted of six different training lesson sessions on the whole, and these sessions were divided into two sessions of evaluation method and four guideline sessions. Because of limited resources, the content of the exercise sessions were

limited. The four exercises of guidelines were divided up as follows: one session for ISO 9241 standards with parts 10, 12, 13, 14 and 16 (ISO 9241, 1999), two sessions for web-design guidelines with using Research-based Web Design and Usability Guidelines (Koyani et al., 2006), and one session for design patterns with using Tidwell's patterns (Tidwell, 2006). The individual exercises included evaluation tasks mainly but a couple of design tasks were also included.

Development process of the exercises

All of the individual exercises based on the specific pedagogical pattern. The pedagogical patterns provide aids for planning education with knowledge of experts' experimental learning. In this case, used pedagogical pattern was chosen by them appropriateness for the individual exercise, and criteria for the selection were making more effective and more satisfying learning. We were selected seven pedagogical patterns in all which based on pattern languages by Bergin et al. (2001, 2002, 2003) and Eckstein (2000).

Exercises were developed in iterative process. At the beginning, we were prepared different text-based exercises based on above-mentioned pedagogical patterns. After this, we were searched the appropriate examples of user interface elements or part of application for illustrating text-based exercises by using web and literature. We were gathered students feedback after every exercise and exercises were changed if needed. The first iteration included two exercise groups with twenty-five students. Also, the second iteration included two exercise groups but amount of students was forty-five. Last iteration included one exercise group with thirteen students. Each of the exercise took three hours.

Desktop design exercise

This exercise based on ISO 9241 standard with parts 10, 12 and 13 (10: Dialogue principles, 12: Presentation of information, 13: User guidance), and GUI Bloopers text book (Johnson, 2000). Only two iterations were used in this exercise. Exercise consisted of six different tasks with discussion and redesign tasks. An example of this exercise is that students had to find design errors from given example and the redesign the example (Table 1). All of the exercises were done in individual work.

After the first two exercise groups, the exercise was mainly liked. Also, the students experienced that this kind of exercises aid to learning guidelines. Exercises which included some evaluations based on students' own opinion or experiences were not liked. On the other hand, exercises which based on the theory of ISO 9241 standard were seemed to be good for learning. According to feedback of students, they wished to do all exercises in groups rather than alone. We concluded to change all individual tasks to group works because of more fruitful learning. Also, some text explanations and picture examples in tasks should be clarified. One students experience was that

ISO 9241 standard was hard and time-consuming to go through. Anyway, we were kept the standard as support material because of all students had not participated in lectures.

Table 1. A well-liked example of the ISO 9241 exercise: “Discuss the given example of list. What are the design errors? Redesign the example.”

Cities
Stockholm
Helsinki
Vienna
Oslo
Copenhagen
Stuttgart
Countries
Finland
Norway
Denmark
Austria
Sweden
Germany

After the second exercise groups, the exercise was mainly liked again. Students experienced that group works were successful solution due to increasing interaction between students. Main problem in almost all tasks were that example pictures had separated from their context. In other words, the students didn't understand the context of example. Thus, we have to keep the context of tasks on hand in future. One general problem was that students have not enough time to do exercises. Perhaps, we have to reduce amount of tasks or increase the working time.

Web-design exercise 1

This exercise based on Research-based Web Design and Usability Guidelines with chapters six to eight (6: Page layout, 7: Navigation, 8: Scrolling and paging). Exercise consisted of seven different tasks with comparing, discussion and redesign tasks. Tasks 1 to 4 were done in individual work and tasks 5 to 7 were done in group works. An example of this exercise is that students had to compare two different search engines (e.g. Google and Yahoo) and explain which one is better and why. Solution had to be grounded on web usability guidelines introduced above. These exercises were mainly liked. However, several students had to do tasks too hurry, because they had not enough time to do exercises. Thus, we reduced amount of tasks from seven to six.

Although amount of tasks were reduced in iteration 2, students had not enough time to do all tasks again. Also, comparing two search engine were experienced useless by students, because of only task with opinion and that kind of tasks doesn't be chastening experience. On the other hand, comparing task could be useful if more than two search engine had to be compared. Based on gathered feedback, we were added one search

engine site more for comparing task. Also, we were clarified description of tasks so that there was references to the appropriate part of web design guidelines. 0

Exercises were liked by students in iteration 3. E.g. comparing search engines task were experienced more useful by student after changes. Furthermore, only problem was lack of time. In future, we have to think again time and tasks relation.

Feedback of the whole exercise was that web-design exercises should be included evaluation, comparing and redesign exercises based on learnt theory.

Web-design exercise 2

This exercise based on Research-based Web Design and Usability Guidelines with chapters thirteen and eighteen (13: Screen-Based Controls – Widgets, 18: Usability Testing) and one article of using frames.

We were paid attention to amount of tasks in this exercise. Thus we were prepared only three different exercises: discussion, comparing and identifying problems. All of the exercises were done in small groups. The most of feedbacks were positives after iteration 1. However, some problems were identified in these exercises. Some concepts (in terminology) were not known by students.

We were clarified the terminology by the next iteration. Exercises were liked by students in iterations 2 and 3 so any changes not needed. Feedback of the whole exercise was that the used article was experienced useless because it was not needed in exercise exactly.

HCI-design Pattern exercise

This exercise based on Patterns for Effective Interaction Design by Tidwell. Exercise consisted of four different tasks with reading, discussion, finding problems and designing tasks. One task was done in individual work and three tasks were done in group works.

Only one problem was identified in iteration 1: students have not enough time to do exercises. Thus, we reduced amount of tasks from four to three. Lack of time was also identified in iterations 1 and 2. In future, we have to think again time and tasks relation.

Properties of user interface design guideline and pattern exercises

During the course several preliminary properties of good and bad exercises were identified by students and staffs. This section summarise the core of these basic principles.

- Exercises should be based on the theory (not students own opinions).
- Exercises should be done in groups (rather than in individual work).

- Students must have a clear understanding of the objectives of the exercise (text explanations and picture examples should be related to each other, and terminology should be explained).
- Exercises should be stated the context of examples (e.g. what is the application and situation).
- Amount of exercises should be suitable with time (e.g. reading work should be removed or at least reduced)
- Exercises should be continuous (e.g. practical work is more intensive work than several short exercises)
- Exercises should be included different tasks (e.g. tasks of comparing, evaluating and designing)
- Exercises should be concrete (e.g. design exercises are more exciting than evaluation exercises)

Conclusion

This study was a one approach to educate user interface design guidelines and patterns for students. Presented set of properties provides a starting point to develop exercises further. Also, lack of earlier research causes needs to research this topic more. During the exercises development process we were developed teaching method: (1) we were developed text-based exercises by way of pedagogical patterns, (2) we were made exercises follow-through guidelines for teachers, and (3) we were made iterations for exercises. As a result, we have the good starting point to carry out new course in future. In future, we have to identify more properties of good exercises. Also, it would be interesting to try identified properties to the other HCI courses.

Acknowledgments

We would like to thank Interaction Design course for providing a research environment. We also thank Dr. Timo Jokela for delivering lectures and feedback on developed exercises as well as other staffs in this course for making exercises and feedback on developed exercises. In addition, this work would not be possible without students in our course.

References

- Apple Computer Inc. (2006). *Apple Human Interface Guidelines*. <http://developer.apple.com/documentation/UserExperience/Conceptual/OSXHIGuidelines/index.html>. Last accessed 2007-04-02.
- Bergin J., Eckstein J., Manns M. L., Marquardt K. and Sharp H., Wallingford E. (2001). "Patterns for experiential learning". <http://www.jeckstein.de/pedagogicalPatterns/experientiallearning.pdf>. Last accessed 2007-04-02.

- Bergin J., Eckstein J., Manns M. L., Sharp H. (2002). "Patterns for Active Learning". <http://www.jeckstein.com/pedagogicalPatterns/activelearning.pdf>. Last accessed 2007-04-02.
- Bergin J., Eckstein J., Manns M. L., Sharp H. (2002). "Feedback patterns". <http://www.jeckstein.com/pedagogicalPatterns/feedback.pdf>. Last accessed 2007-04-02.
- Deng, J., Kemp, E. and Todd, E. G. (2005). "Managing UI pattern collections". *Proceedings of the 6th ACM SIGCHI New Zealand chapter's international conference on Computer-human interaction: making CHI natural*, July 07-08, 2005. Auckland, New Zealand 31-38.
- Eckstein J. (2000). "Learning to Teach and Learning to Learn. Running a Course." <http://www.pedagogicalpatterns.org/examples/LearningAndTeaching.pdf>. Last accessed 2007-04-02.
- Henninger, S., Haynes, K. and Reith, M. W. (1995). "A Framework for Developing Experience-Based Usability Guidelines". *Proceedings of DIS '95*. ACM Press 43-53.
- International Standards Organization. (1999) ISO 9241: Ergonomic requirements for office work with visual display terminals. Geneva, Switzerland.
- Johnson, J. (2000). *GUI Bloopers: Don'ts and Do's for Software Developers and Web Designers*. San Francisco, Morgan Kaufmann.
- Koyani, S.J., Bailey, R.W. and Nall, J.R. (2006). *Research-based Web Design and Usability Guidelines*. Dept. of Health & Human Services, National Institutes of Health Publication 03-5424, National Cancer Institute, Washington, DC. <http://www.usability.gov/pdfs/guidelines.html>. Last accessed 2007-04-02.
- Mariage, C. and Vanderdonckt, J. (2004). "Creating Contextualised Usability Guides for Web Sites Design and Evaluation". *Proceedings of 5th Int. Conf. on Computer-Aided Design of User Interfaces CADUI'2004* (Funchal, 12-16 January 2004). Kluwer Academics, Dordrecht.
- Mariage, C., Vanderdonckt, J. and Pribeanu, C. (2004). "State of the Art of Web Usability Guidelines". Chapter 41, in R.W. Proctor, K.-Ph.L. Vu (eds.), *The Handbook of Human Factors in Web Design*. Lawrence Erlbaum Associates, Mahwah.
- Microsoft Corporation. (1995). *The Windows interface guidelines for software designers*. Redmond, WA: Microsoft Press.
- Mosier, J. N. and Smith, S. L. (1986). "Application of Guidelines for Designing User Interface Software". *Behaviour and Information Technology*, Vol. 5, No. 1, Jan-Feb 1986 pp. 39-46.
- Tidwell, J. (2006). *Designing Interfaces – Patterns for Effective Interaction Design*. <http://designinginterfaces.com/>. Last accessed 2007-04-02.
- van Welie, M. (2001). *Patterns in Interaction Design*. <http://www.welie.com/index.html>. Last accessed 2007-04-02.

Technologies, Communities and Broadcasters: investigating the use of digital technologies by UK ethnic minority radio broadcasters

Authors: John Cawood and Eleanor Shember-Critchley

Affiliations: The Information Research Institute, Manchester Metropolitan University, United Kingdom

Email addresses: j.cawood@mmu.ac.uk / mscrow@mscrow.com

Abstract. This paper addresses the role of technology in the changing environment of ethnic minority broadcasting. Our approach has been informed by a Social Constructionist perspective in which socio-technical change is seen as the product of the interaction of relevant groups following contingent social interests. The empirical results of our research have raised some questions relating to the conceptualisation of relevant social groups and to the insecurity of what at first appeared to be a stable consensus on the introduction of digital technology. These difficulties prompted an examination of some later articulations of the social constructivist paradigm. Actor Network Theory is discussed and its detailed description of the mechanisms which hold socio-technical networks together shown to be useful in understanding why ethnic minority radio stations are poorly represented in digital audio broadcasting and why they have increasingly turned to Internet and Satellite technologies..

Keywords. Ethnic Minorities, Radio, Broadcasting, DAB, Internet, Satellite, Social Constructionism, SCOT, Actor Network Theory, ANT.

The questions addressed in this paper arise from a pilot study which sought to assess the role of broadcasters, communities and technologies in shaping ethnic minority radio in the UK. The use of digital transmission emerged as a central theme of the research when its attention turned to the technologies which stations employ to reach their listeners. Technology is often taken as a given in studies of the media and tends to be treated in an essentialist and deterministic way. More recent investigations and the work presented

here have approached broadcasting as a socio-technical construction. Broadcast media play a significant role in the social and cultural life of communities. Technologies and culture are so intertwined that some have suggested that in this context, we should speak of techno-cultural hybrids (Davis, 1998).

Our pilot study investigated ethnic minority broadcasting at a time of significant technical change in which older analogue technologies are being replaced by digital transmission. In the UK (and some other European states), one technique of digital transmission, Digital Audio Broadcasting (DAB), appeared to be emerging as the dominant technology. In the language of social constructionism, “stabilisation” or “closure” seemed to be occurring. However, our investigations showed that ethnic minority stations, which were either excluded from DAB or which have chosen not to employ it, were using other digital technologies to present their programmes to listeners in ethnic minority communities. In addition, some of the ethnic minority stations which have taken up DAB are also broadcasting on the Internet and using satellite channels. The development of other systems of audio broadcasting, uncertainty surrounding the future of DAB and the presence of alternative digital systems for programme delivery prompted a return to the methodology informing our study. Perhaps our notion of stabilisation was an oversimplification. Could other concepts of socio-technical change be better suited to the investigation? The objectives of this paper are:

1. Review the main concepts of social constructionism.
2. Summarise the results of our empirical research in the context of these concepts
3. Make some suggestions for further work in the light of the methodological difficulties which have been encountered.

The Social Construction of Technology (SCOT)

In the SCOT perspective, stable technologies are constructed by the complex interaction of social interests. (Bijker, Hughes and Pinch, 1997) In the case of radio broadcasting, these interests would include commercial and community broadcasters, policy makers, manufacturers, engineers, government regulators and the audience. Such relevant social interest groups (RSGs) hold differing interpretations of the nature and use of a technology (“interpretive flexibility”) which, until “closure” is achieved, has no pre-determined form or purpose. In other words, there is no essential element of the technology which determines its use and future development. This interpretive flexibility of technology is evident in our own study We can see that the purpose of radio technology perceived by the larger commercial broadcasters is very different to that which is held by a small community based stations. According to SCOT, stabilisation and closure of a technology come about when a consensus of interests is built around a particular interpretation of that technology or the interpretation of one particular interest

group becomes dominant. Once stabilisation takes place, it is argued, re-opening discussion of the nature and purpose of the technology is extremely difficult.

In our study of ethnic minority broadcasting, we turned to SCOT as an explanatory framework since it seemed appropriate to the investigation of a relatively weak group of actors, the ethnic minority stations, which found themselves in the midst of a technological paradigm shift, the move to digital radio broadcasting. At first sight, digital broadcasting seems to offer several general advantages to ethnic minority broadcasters. These include better quality sound reception and, more importantly, an increase in the number of stations which could be transmitted on a given bandwidth. Digital multiplexing (explained below), it might be thought, would open up broadcasting to community based stations as the new technology overcame the problem of scarcity of frequencies. Finally, it might be assumed that the dominance of the bigger players would ensure the compliance of the smaller interests which would be forced to conform to the consensus. An examination of the context of ethnic minority broadcasting in the UK will explain why this hasn't happened.

The Context of Ethnic Minority Broadcasting in the UK

Ethnic minority radio is still relatively fragmented in the UK in comparison to the more cohesive ethnic minority broadcasting policies of countries such as Norway, Canada and Australia. It has been an issue since 1965, when, during the first major periods of immigration, the government researched special programming requirements and formed the BBC immigrant programmes unit. Little was done concertedly to produce appropriate programme content. Programmes aimed at the South Asian and Afro-Caribbean communities started to emerge on local radio stations in the mid 1970's and had a positive response. Radio reached audiences in their own language, supplying news, information and education to often isolated members of the local community

The 1980's saw an expansion of ethnic minority programming though not always as part of legitimate licensed operations. Pirate radio still had a presence in the broadcasting landscape and provided a space for ethnic minority stations such as the Dread Broadcasting Corporation and London Greek Radio (LGR). LGR started as a pirate station looking for way into providing legitimate programming for the Greek/Cypriot communities it represented. The decade was a difficult time for ethnic minority stations as the new Conservative government began to apply its free market policies to community radio broadcasting and animosity from the commercial networks increased.

The 1990 Broadcasting Act followed seven years of consultation with the new ethnic minority and other niche stations but it swiftly put paid to any hopes of public funding and support. The Act itself did not seek to define ethnic minority radio or set aside central

funding. Instead, new stations entering the market faced a sink or swim situation as they battled for advertising revenue with professional commercial stations and faced restrictions on the service licences which regulated their broadcasts. The uncertainty produced by such factors made forward planning difficult. Many observers at the time felt that an opportunity to bring ethnic minority broadcasting under a public service umbrella had been missed. Listeners were no longer listeners but consumers and programmes became commodities.

Nevertheless, ethnic minority stations did continue to grow in the commercial environment of the 1990's. However, under fiercely competitive conditions, stations such as London Greek Radio and Spectrum Radio tended to restrict themselves to urban areas; others found local finance, particularly in the wealthier Asian communities where traditionally there has been a greater propensity for financial backing. Differences in funding opportunities led to an imbalance in the stations which represented the UK's diverse ethnic communities.

Alongside the changes which occurred in the regulatory framework, finance and structure of British radio broadcasting, technology had been moving apace. The digital techniques which had begun to transform telephone services, newspaper production and image manipulation was about to be applied to television and radio. Indeed, the expansion of digital technology cannot be separated from the wave of deregulation and liberalisation which characterised the period. In the expanding market for digital technologies, European governments, telecommunications manufacturers and broadcasters fought hard to be leaders in the development of products and standard setting for the digital market. In the radio sector, the multiplexing of transmissions which digital broadcasting permitted fitted the free market model well since more widely available frequencies held the promise of a truly competitive environment in which a high level of government regulation was unnecessary.

Digital Audio Broadcasting (DAB)

Supported by the European Union, the Eureka 147 Project, a consortium of 12 countries, had developed a new way to broadcast both radio and data services under the name Digital Audio Broadcasting (DAB). The DAB system of digital radio transmission shares some of the characteristics of mobile telephone technology. The area covered by the broadcasts is divided into cells. The digital signals are transmitted in the VHF wavebands and a receiver may take parts of a transmission from different cell sites so that an optimum signal quality is maintained. DAB allows several digital signals to be transmitted on the same waveband and thus overcomes, in part, the scarcity of frequencies which restricts the number of stations in traditional analogue broadcasting. This technique is known as multiplexing and a DAB "multiplex" allows several stations to transmit on the same VHF waveband. In addition, compression is used to maximise the use of available frequencies. The method of coding audio signals in digital format, the

type of multiplexing and signal modulation, the method of error correction and so on together with the cellular structure of VHF broadcasts define DAB technology.

The protocols for DAB, finalized in 1993, were adopted by the European community in 1995 and by the major international standards bodies around the same time. Pilot broadcasts were launched in several countries in 1995 and the UK became the first country in which a wide range of stations were made available. Commercial DAB receivers appeared in 1999. DAB was promoted as a means to deliver near CD sound quality, graphics and simultaneous data transmission such as streaming announcements. In practice, the sound quality of DAB has often not been as high as existing FM services as attempts were made to squeeze more digital transmissions into the coding and compression system used by DAB. Other problems have also appeared. The use of the VHF cellular system means that wide coverage can only be achieved once an extensive network of DAB transmitter sites is established. The re-use of frequencies made possible by shorter range VHF transmissions has to be set against the longer distance transmissions which analogue long, medium and short wave broadcasts can achieve. Such a capability is attractive to smaller minority stations which want to broadcast to a diverse audience.

In the UK, digital radio licences are sold as a tenancy to a multiplex owner who then appoints radio stations who fit the remit of required services. The tenancies are sold in a bidding process regulated by Ofcom and in this way, the multiplex owners act as “gatekeepers” for digital services. As the regulator put it:

“Ofcom advertise licenses to own the multiplexes so the then owners of the multiplexes set their own fees to the programme providers, we only license the gatekeeper so to speak.

The owners of multiplexes are free to choose individual programme providers for the different types of services they have promised in their DAB multiplex licence. For example, if their multiplex licence requires them to run an Alternative Rock service, they could – for instance – choose between Xfm, Kerrang or another radio station, as long as it broadly had that particular format.” (Ofcom Telephone Interview, 2006)

Most UK DAB multiplex licences are awarded for local broadcasting. The large media operators bid for them and then allocate bandwidth to nominated stations which provide the services specified in their application. These operators such as GCap Media, CE Digital, CXR and Emap Digital generally nominate stations which they own themselves. The consequences of this practice for ethnic minority stations will be discussed below. Until recently, the only existing commercial national multiplex was Digital One which is run by GCap Media, a large broadcasting group which produces mainstream content.

DAB was to re-energise an already flagging commercial market, particularly as lower operating costs were offered to the existing analogue licensees whereby their take-up of a

DAB licence was combined with an automatic rollover of their existing FM/AM licence. As such, existing analogue licensees were able to avoid the costly reapplication process. The DAB rollout in Britain began.

Doubts about DAB in Ethnic Minority Broadcasting

By 1996, at the Media Wise conference for ethnic minority media in London, voices were being raised against the consensus for DAB. A 'rosy future for everyone' was not the view shared by the smaller, commercial ethnic minority stations. There was a 'fear that ethnic minorities could miss out unless the government steps in with tough regulation and funding...With market forces alone ethnic minorities will be squeezed out.' (PressWise, 1997). Clearly, the system of allocation of bandwidth on the DAB multiplexes which has been described above provoked fears that they were being marginalised by more powerful mainstream radio interests

These fears were partly answered for the analogue broadcasting in the Government's 2003 Broadcasting Act. This sought to right the imbalance of community radio in the commercial sector by providing limited funding and setting tight regulations for content, financial practices for seeking revenue and controls over advertising. These measures replaced the much disliked restricted service licence and stations were able to apply for full broadcasting licences, albeit in a restricted broadcasting area. However, this welcome change was seen as quite separate to the allocation of space on the digital multiplexes. Questions about available space on the already full regional multiplexes arose.

Central to the pilot study were interviews with a variety of ethnic minority radio stations operating in the London area. Stations were chosen to reflect the varying licensing scenarios of the commercial, community and public sectors. Semi-structured interviews aimed to capture broader views of important issues and of the changes taking place within broadcasting which directly affected ethnic minority radio. The stations were also chosen to reflect the diversity of broadcasting technologies employed.

Ethnic Minority Stations Interviewed during the Pilot Study

Spectrum Radio – a commercial multiethnic radio station broadcasting on DAB, Satellite, analogue and the Internet financed by leasing airtime in hour slots to different ethnic minority groups. These groups run a mini station within their slot, selling advertising and broadcasting mostly in their own languages. Spectrum was one of the first commercial licence holders following the 1990 Broadcasting Act along with London Greek Radio.

Chinese Spectrum Radio – leases commercial airtime from Spectrum Radio broadcasting simultaneously on the AM signal and the Internet. Chinese Spectrum has

been broadcasting for 10 years. It broadcasts to the local London community mostly in Cantonese using a magazine style.

Asian Gold Radio - a commercial satellite and Internet only Asian station. It broadcasts in a similar style to Spectrum, selling its airtime to religious groups when not following a mostly music format.

Desi Radio – a community Punjabi station broadcasting on satellite, analogue and the Internet. Desi won one of the first access licences following the 2003 amended bill to allow for community broadcasting. It broadcasts to the Southall Punjabi community where it also gains funding from local groups as well as restricted advertising revenue.

BBC 1Xtra – is a public service radio station broadcasting young black orientated music on the Internet, satellite and DAB. 1Xtra was the first DAB-only offering when the BBC gained its digital licences which it used to create an urban aware music format aimed at nurturing UK talent.

London Greek Radio – a commercial Greek station broadcasting on analogue, the Internet and satellite. LGR has pirate origins and has been legitimately broadcasting to the Greek community in London for sixteen years mainly in Greek/Cypriot and using a mixed format of music and speech

Voice of Africa – a community station broadcasting to London’s African community at the time only by the Internet, but which has since received its analogue licence. VOA began as London’s only African station and removed its pirate rigs to gain its licence; it aims to provide content for all generations and identities within the African Diaspora.

Issues Raised by Ethnic Minority Broadcasters

In terms of the general industry, it was widely felt that mainstream radio i.e. commercial broadcasting was creating a homogenous product where the

‘commercial radio stations pander to the most (sic) common denominator which is pop music or music of a particular genre just to get the amount of people listening and so they can sell the advertising. It’s a vicious circle’ (Spectrum Interview, 2006).

A related common concern was the convergence of ownership. Significantly the DAB multiplexes are owned by a small number of media corporations which produce the majority of analogue output.

Some stations felt the opportunity for diverse content was being lost through corporate ownership for content was becoming a product to be marketed with examples such

as '[Kiss who] were bought out to make money and Kiss albums sell more than probably what they make on advertising' (1Xtra Interview, 2006).

Radio Joint Audience Research (RAJAR), the part public, part private body which collects audience statistics regularly came up in interview. Where minority stations had been RAJAR members, statements such as the following were common:

'RAJAR came back with very poor results...at the time in possibly 1994, there were over 100,000 Greek Cypriots in the area and I can assure you that had you gone to any Greek household they would have been listening to LGR. Now it's the will of RAJAR that they cannot be bothered to change the way they do this research' (LGR Interview, 2006).

Some went further viewing the relative power as possibly harmful to the development of ethnic minority radio:

'it's an absolutely outrageous scandal in fact that the only organisation that measures radio figures that's taken as a common currency don't do enough to cater for ethnic radio stations because they're pandering to the larger radio groups. And let's not forget who owns RAJAR - it's owned half by the BBC and half by the Commercial Radio Companies Association and who sits on the board? Oh, surprise, surprise, all the large radio groups. Some people might say it's a conspiracy or some kind of cartel run by the large radio groups' (Spectrum Interview, 2006).

All the stations interviewed were exploring the Internet as a broadcast medium and six were also using satellite channels. Most felt that technologies other than DAB held more promise for the extension of their broadcasting footprint and of reaching a diverse audience. For instance, it was felt that Web broadcasting was more likely to reach younger members of relevant community. If the 'closure' of a technology as Pinch and Bijker suggest is subject to the 'choices, interests and value judgements' of the relevant social groups, it seemed to be the choice of the minority stations interviewed to pursue other broadcasting avenues and to reject the "closure" which DAB might represent.

The attitudes of the minority stations towards DAB have to be seen in the context of other developments which threaten the stabilisation of the technology. Alternative digital techniques and standards have been developed elsewhere which undermine confidence in DAB. A French led consortium has developed DRM (Digital Radio Mondial) which offers digital broadcasting on the existing long distance analogue wavelengths. This has obvious attractions to minority stations serving trans-national communities. Finally, problems with the quality of DAB have prompted a series of modifications to the technology some of which are incompatible with the original standard. Such a weakening of support is reinforced by statements such as the following from the UK radio regulator:

'there is no guarantee and hasn't ever been the guarantee that existing licensees would transfer...we licence DAB but we're not necessarily biased to DAB, so other technologies may be licensed in the future' (Ofcom Interview, 2006).

This less than fulsome support for DAB indicates a divergence of interests as the commercial multiplex operators do their best to protect their DAB territory by determining operating prices. The operator proposes the services that will be broadcast on their local multiplex; these spaces are sold to stations prepared to pay the determined price. These leasing stations are usually owned or associated with the multiplex operator, thus squeezing the smaller stations out of the local broadcast area and protecting their commercial interests. It would appear then that the drive towards DAB is fulfilling previously voiced fears of the creation of ‘haves’ and ‘have-nots’, for there is a crowding out of smaller stations occurring on DAB. Spectrum Radio was the only commercial ethnic minority station to have taken up a DAB license. The choice to do so was driven not by the perceived future DAB held but as a means of gaining a longer extension to their existing and more lucrative analogue licence for AM broadcasting.

A common theme which emerged from the minority stations interviewed was a wish that Government would ‘grow teeth’ to protect ethnic minority radio – a view similar to those expressed at the PressWise conference. It was widely acknowledged that DAB radio was too expensive for the majority of minority stations and existing space issues prompted responses like the following:

‘We haven’t heard anything from government...why don’t you give the AM and FM channels to the communities because otherwise what are you going to do?’ (Desi Interview, 2006).

This view was also shared by 1Xtra which did not believe that the analogue signal will be switched off for a long time. Ofcom agreed:

‘[DAB] was set up by parliament, it’s not necessarily the case that the signal will be turned off for radio... there’s no centrally driven strategy, we aren’t going to say DAB is for everyone and this is just personal but I think we can expect there to be different ways to deliver radio’’ (Ofcom Interview, 2006).

It was widely felt that DAB would have been more successful had there been a unique selling point, either in the form of automatic inclusion in new cars as done in the USA or by using it to carry a widely sought for service in the way Sky used its rights to Premiership football. Ofcom agreed: ‘in the States you can look at Howard Stern on pay radio - that has driven subscriptions’ (Ofcom Interview, 2006). However, the UK public have never had an inclination to pay for services outside the licence fee, so pay radio would have been a difficult proposition. Ofcom suggest that the BBC may switch off one of their prime services as a way of moving listeners over but this would seem to be a long way off.

Internet and Satellite Broadcasting

DAB, unlike analogue shortwave broadcasting is restricted by geographical boundaries. However, an alternative digital technology, the Internet, is not and the small ethnic minority stations were already aware of its potential. Perhaps ironically, the international nature of the Internet is seen as a threat by the big commercial stations. Since commercial radio's business models are all "based on the idea that geographical regions are meaningful" (Grossman, 2006), the bigger players are to a large extent constrained to fight it out for UK advertising revenue which is tied to geographical regions served. The smaller stations with trans-national orientations are not so constrained. As our research shows they are using the Internet differently and sell airtime, space and facilities rather than being advertising dependent.

Minority stations were exploring interactive technologies since the diversity of ethnic minority audiences meant that the use of familiar technology was the best way to encourage listeners from all generations. By encouraging interaction with the station, 'we're thinking of the youngsters on the computer all the time where they can dedicate songs, use our website to put up messages, it's like a central forum, because we've been around for so long people think to tell us so we can put a message out' (Chinese Spectrum Interview, 2006).

Internet working brings its own problems. Ofcom is unable to provide a framework for broadcasting until the Government recognises fully the impact that Internet radio might have. Ofcom admits that 'we can't license the Internet, we regulate analogue because radio is a scarce supply. You or I could set up an Internet radio station and even if you want to regulate you couldn't.' (Ofcom Interview, 2006). Aside from revenue losses by Government, the absence of regulation could have a larger social impact for if anyone can set up a station and broadcast to UK territory, who is going to regulate the content?

When Ofcom was asked about the enthusiasm for Internet take-up by the minority stations interviewed it replied:

'with the Internet it's not something we can have any input. There's god knows what on the Internet, pornography etc so Internet only radio stations are out of our jurisdiction, we can only regulate licence holders' (Ofcom Interview, 2006).

Already on satellite there are concerns about negative discourse being broadcast by more fundamentalist groups accessing airtime in a largely unregulated medium. However, this is an area in which Ofcom is able to grant licences and thus regulate. The representative of Asian Gold was strongly in favour of regulation: 'I just wish they would take a lot more care in monitoring Asian stations, not just in the output but if you talk to other industry people they feel they just concentrate on the big guys' (AGR Interview, 2006).

In the UK it is the Department of Culture, Media and Sport which has ultimate responsibility for the policy framework in which DAB and indeed Internet and satellite radio will take shape. It appears at this point, however, that there is a reluctance to acknowledge the changes taking place, many without a regulatory framework. The Department of Culture, Media and Sport were contacted as part of this study as Ofcom indicated the DCMS were in a better position to answer questions on strategy. They did not respond.

Discussion and Conclusion

The Concept of Relevant Social Groups

In the analysis of the use of technology by UK ethnic minority broadcasters, we have found the social constructionist approach to be extremely valuable in theorising the interaction between the various groups of actors and the broadcasting technologies available or under development. The concept of the relevant social group is a fruitful way to account for the diverse interests at work in radio broadcasting and for the different conceptions of technology which they hold. However, in its original form the formulation of a relevant group has proved to be an inadequate account of the manifold and often subtle social and economic differences which characterise RSGs. Differences in the power to influence technical change, differences in social, commercial and other values need to be accounted for. This can be a complex task. As Humphreys has commented, the original formulation of RSGs does not account for 'class, race, gender and ethnicity [which] may be important factors in the evolution of technology...the choice of relevant social groups may be relativistic and subjective thus leading to an oversimplified understanding of technology and society' (Humphreys, 2004).

These difficulties with the SCOT conception of a relevant social group led us to review models from other disciplines which sought to explain technical developments in terms of the interaction of social interests. One such candidate, developed in the field of political economy is the notion of policy networks. (Rhodes 1990). However, policy network analysis in common with several other theories from the economic and political sciences tend to regard technology as autonomous. Our wish to open up the technological as well as the social led us back to the social constructionist paradigm and a somewhat different conception of the actors involved in socio-technical change. Before we examine this conception, we must also investigate a further problem arises from the application of the SCOT approach.

Stabilisation and Closure

At the beginning of our pilot study (2005), DAB seemed to represent a closure of the debate on which form of digital broadcasting should be deployed in the UK. DAB had the backing of the UK Government, the European Union, large manufacturers, major

broadcasters such as the BBC and many of the commercial broadcasters which had taken advantage of a more market oriented broadcasting regime in the UK. However, our research has revealed that:

- a) the smaller ethnic minority stations were effectively excluded from DAB and were exploring alternative ways of delivering digital broadcasts.
- b) the more successful commercial minority stations which did buy space on the DAB channels, did so to extend their analogue licences rather than from enthusiasm for the new technology. Moreover, they were investigating the same alternative technologies as the smaller stations
- c) analogue delivery continued to be the principle means of ethnic minority broadcasting and its technology of choice.
- d) developments in the wider world of radio broadcasting were undermining confidence in DAB as the dominant digital audio technology
- e) problems with the quality of DAB have prompted a series of modifications to the technology some of which are incompatible with the original standard.

Such a situation appears to be incompatible with the idea of closure. Either a stabilised form of digital audio broadcasting had not yet been achieved or the notion of closure needed to be revisited. If closure is ‘the point at which relevant social groups consider their problem with the artefact to be solved’ (Humphreys, 2004) then our research shows that in the case of minority radio, the technology which is regarded as closed by some powerful relevant groups is resisted, bypassed and subverted by some of the weaker groups.

Similarly, if ‘stabilisation is a process by which members of a relevant social group come to communicate definitions and specifications of an artefact similarly over time’ (Humphreys, 2004) it supposes that the technology is universally adopted and only minor points are the subject of ongoing discussion. This does not seem to be the case for the digitalisation of radio where the position of DAB is already challenged. When we look at current technologies such as mobile telephone systems and other information and communications technologies, we see similar pictures to those we have described in digital broadcasting. There are rival technological systems and standards which have a greater or lesser hold in different geographical, commercial and social arenas.

One route out of this dilemma is simply to declare that DAB never did represent closure and that we are still in a period of high “interpretive flexibility”. It seems to us that such a move critically undermines the explanatory power of the SCOT approach and limits it to the analysis of historical developments where the benefit of hindsight can be used to identify the stabilisation of a technology more precisely. In order to preserve the insights which the SCOT approach offers but to overcome the difficulties which have been encountered, a less rigid notion of stabilisation seems to be required. Such a notion

is offered by Actor Network Theory, a perspective which has its roots in the social constructionist approach.

Actor Network Theory

According to Actor Network Theory (ANT), technology is the end product of a process in which human, social and technical elements (technical equipment, engineers, journal articles, computer terminals, etc.) are fitted into a patterned network which orders their individual interests (Latour, 1986; Law and Callon, 1988). Technologies are created by a process of "heterogeneous engineering" (Law, 1988) in which a variety of components from the social, the technical, the conceptual and the textual are fitted together, and so "translated" into a set of equally heterogeneous technological products. What is true for technology is also applied to other institutions and thus, organisations such as broadcasting companies and international radio standards setting agencies may be similarly pictured. All of these are ordered networks of heterogeneous materials which are configured by negotiation.

In this approach, over-arching social and economic structures from which the details of local activity might derive are not taken for granted. The same explanations operate at all levels. Thus, the executives of multinational companies are no different in kind to the managers of small, ethnic minority radio stations. If Galaxy Radio is bigger and more powerful than London Greek Radio, then we need to account for how this comes about.

The ANT notion of a heterogeneous socio-technical network is a metaphor but an actor-network should not be taken as a stable web of interconnected elements. It is not a technical network like a railway or a telephone system. It does not have fixed nodes or set paths. Care is needed with the ANT use of the term network since it is used in a specific way to describe shifting alliances of actors and not a fixed entity. Physical networks such as cellular radio systems and the Internet are examples of possible stabilised states of an actor network but are only partial projections of that network.

Actors in the network may be people, but they may equally be organisations, machines, texts or anything else. Whilst some actors are more powerful than others in the ordering and translation of interests, all actors are equal in terms of their explanatory status. In this way, Actor Network Theory transcends the debate on social and technological determinism. People, machines, texts and organisations are interactional effects in networks rather than primitive causes. Thus, on a small scale, the building of an ethnic minority radio service might entail the conscription of interested parties by its proponents. These allies might be technologists, digital radio technologies, community and religious groups, communications networks, business interests and EU policy statements.

The inclusion of both human and non-human elements in an actor network is a controversial move. However, it enables a more detailed description of the concrete mechanisms which glue socio-technical networks together to be made. In addition, it overcomes the difficulties of technological and social determinism since there is no reason to assume, a priori, that either technologies or people in general determine the character of social change or stability. In particular instances, social relations may shape technologies, or technological systems may shape organisational structures. This is an empirical question which requires investigation.

Interests, Translation and Inscription

The stability of a socio-technical network is achieved by aligning or ordering the interests of network actors. This is a process of continual negotiation as actors have diverse interests and stability rests crucially on the ability of an actor to translate, that is to re-interpret, re-present or appropriate others actor's interests to their own.

In translation the same interest may be presented in different ways in order to mobilise broader support. Thus, DAB has been presented as a way of strengthening Europe's position in the manufacture of digital broadcast technologies and as a means to provide a multiplicity of local radio services whilst protecting market interests. A translation requires a medium or material into which it is inscribed and in this way translations are embodied in machines, skills and texts. One such text might be the set of protocols for the operation of Digital Audio Broadcasting.

In ANT terms, the design of a technology such as DAB is a process of translation. Here users' interests are translated into specific needs and these are further translated into more general and unified needs so that these needs may be translated in one and the same solution. When the technological system is running, it may be taken up by other users who translate the system into the context of their specific work tasks and situations.

In the case of Digital Audio Broadcasting, the engineers and managers who participated in the Eureka147 project worked out the use of the DAB technology. These intentions were inscribed into the DAB system and included programmes of action for users and defined roles to be played by users and the system.

The inscribed patterns of use may or may not succeed because the actual use may deviate from the intended use. Some types of inscription are more powerful than others. "Thoughts are cheap but they don't last long" (Law, 2003). However, if we embody them in inanimate materials such as texts and machines, they can last longer. A relatively stable network is one embodied in and performed by a range of durable materials such as national audio broadcasting infrastructure. In a stable network, there is a consensus amongst actors on previously contested issues. For instance, in digital broadcasting, a particular method of delivering digital signals comes to be taken as given. Engineers and

designers do not then spend time reopening the debate but use the agreed technique to get on with their work.

However, stability according to Actor Network Theory is far more precarious than earlier social constructionists would allow. The formation of a stable network is not the end of the story as networks are always unreliable and can become unstable. The entry of new actors, desertion of existing actors or changes in alliances can cause the agreed solutions of a stable network to be opened and their contents reconsidered.

Conclusion

In the light of our empirical research, Actor Network Theory seems better able to theorise the complex and shifting digital broadcasting environment and improves on the original social constructionist approach which we adopted. It allows us to take account of local, national and global players and to locate them in a framework which includes technological as well as social and commercial change. From an ANT perspective, ethnic minority radio in the UK is a fragmented, relatively weak and unstable socio-technical system. It is a collection of networks which are only partially aligned and whose interests are not inscribed in a material infrastructure which has a common pattern of use.

Small stations mix analogue and digital technologies in an opportunistic manner to reach their ethnic minority audiences. Local actors can choose to employ particular technologies but have little power to re-shape this technology to fit their own needs. They are either conscripted into the more powerful network which is DAB or excluded from it and so turn to satellite or Internet broadcasting. By forsaking DAB, the ethnic minority stations contribute to its growing instability. As engineers, radio companies and broadcasting organisations grapple with the problems which DAB faces, previously agreed technological solutions are being questioned and alternatives considered. The ethnic minority stations have little power to influence the shaping of alternative technologies directly but as users and potential users, they may become actors in new networks which produce technologies better suited to their purposes than DAB is proving to be.

References

- BIJKER, W.E. (2001). "Understanding technological culture through a constructivist view of science, technology, and society", in CUTLIFFE, S & MITCHAM, C, (eds). *Visions of STS: counterpoints in science, technology, and society studies*, pp.19-34, Albany: State University of New York Press.
- BIJKER, W.E., HUGHES, T.P, et al. (1987). "*The social construction of technological systems: new directions in the sociology and history of technology: Workshop: Papers*". Cambridge, Mass.: MIT Press.

- CALLON, M. (1986). "The Sociology of an Actor-Network: The Case of the Electric Vehicle", in CALLON, M et al, (eds). *Mapping the Dynamics of Science and Technology*, pp. 19-34, London: Macmillan Press.
- DAVIS, E. (1998). "*Techgnosis*". New York, Harmony books.
- GROSSMAN, W, (2006). "Will Licensing Kill the Radio Star?" [online] [cited 4 May 2006] <<http://media.guardian.co.uk/radio/story/0,,1766707,00.html>>
- HUMPHREYS, L. (2004). "Reframing Social Groups, Closure, and Stabilization in the Social Construction of Technology", *Social Epistemology*, vol. 19, no. 2-3, 231-253.
- LATOUR, B. (1986). "The Powers of Association" in LAW, J, (eds). *Power, Action and Belief*, pp. 264-280, London: Routledge & Kegan Paul.
- LATOUR, B. (1987). "*Science in Action: How to Follow Engineers and Scientists through Society*". Milton Keynes: Open University Press
- LAW, J. (1987). "Technology and heterogeneous engineering: the case of Portuguese expansion", in BIJKER, W.E, HUGHES, T.P, PINCH, T.F (eds). *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, pp. 111-34, Cambridge, MA: MIT Press.
- LAW, J. (2003). "Notes on the Theory of the Actor Network: Ordering, Strategy and Heterogeneity" [online] [cited 7 April 2007] <<http://www.comp.lancs.ac.uk/sociology/papers/Law-Notes-on-ANT.pdf>>
- LAW, J & CALLON, M. (1988). "Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change". *Social Problems*, vol. 35, no. 3, 284-297.
- PRESSWISE & THE COMMUNITY MEDIA ASSOCIATION. (1997). "Convergence, Regulation and Ethnic Minority Communities in Britain", in *Ethnic Minorities and the Media Forum – Telling it like it is*, London, 29 November 1997, 1-11.
- RHODES, R.A.W. (1990). "Policy Networks: a British Perspective", *Journal of Theoretical Politics*, vol. 2, no. 3, 293-317

User satisfaction in ageing workers' use of information systems

Kirsi Päykkönen

University of Lapland

Faculty of Social Sciences

Finland

kirsi.paykkonen@ulapland.fi

Hannakaisa Isomäki

University of Jyväskylä

Information Technology Research Institute

Finland

hannakaisa.isomaki@titu.jyu.fi

Abstract. This paper describes a study where usability and user acceptance of an information system used by the Finnish police were examined. At the time of the study, the new graphical user interface for data input had been introduced to the users of the system. The aim was to find out how this new interface was accepted among its numerous and diverse users, and what kind of usability problems the users had perceived. The focus of the paper is on how usability correlates with user acceptance, and how the ageing workers differ from the younger ones in terms of user acceptance in the situation where use of an information system is mandatory.

Keywords. Ageing, User Satisfaction, Usability, Mandatory Use.

Introduction

The older age group in the labour market is increasing continuously. At work, using an information system is often obligatory. Implementing lifelong learning and extending working life for those who want to remain in work are current challenges (Dixon, 2003). Therefore becoming conscious of needs of older users

vitally important in information system (IS) and user interface design. Lack of previous computer skills should not be an insuperable obstacle when ageing labour's employment is considered.

Usability of an information system appears in user acceptance by how the users perceive the ease of use and usefulness of the system (Davis, Bagozzi & Warshaw, 1989). Although workers will use the information system in mandatory situations, low user acceptance can impair work satisfaction and attitudes towards the organisation (Brown et al., 2002). Therefore it is profitable to make essential information systems in work place easy and satisfactory to use.

Though there are no significant differences in attitudes towards information technology between ageing and younger users (Kelley et al., 1999), older adults differ from the younger ones as a user group. There is individual variation in physical, cognitive, and sensoric functions (Gregor, Newell & Zajicek, 2002), and ageing users' characteristics yet usually change in the course of time (Zajicek, 2005). Good usability is found to help all users, but especially older adults benefit from it (Zajicek, Wales & Lee, 2004).

This paper describes a study where usability and user acceptance of an information system used by the Finnish police were examined. At the time of the study, the new graphical user interface for data input had been introduced to the users of the system. The aim was to find out how this new interface was accepted among its numerous and diverse users, and what kind of usability problems the users had perceived. The focus of the paper is on how usability correlates with user acceptance, and how the older workers differ from the younger ones in terms of user acceptance in the situation where use of an information system is mandatory.

Usability, user acceptance, and ageing users of information systems

An extensive information system like the one used by police has users with diverse age structure. Since using the IS at work is usually obligatory, users have to endure possible lack of usability, regardless of their acceptance toward it.

Usability and user acceptance when use is mandatory

One frequently cited definition of *usability* is in the ISO 9241-11 standard: it is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Bevan, 1999). Meaning of usability can be summed up in that with an IS with good usability the user can concentrate on his or her tasks, not on the use of the system (Rubin 1994, 9).

According to the Technology Acceptance Model (TAM), user's attitude toward using an IS and further, *user acceptance*, can be explained by perceived usefulness and perceived ease of use (Davis, 1989; Davis et al., 1989). *Perceived usefulness* represents if a user believes that using a system will make his or her job performance more effective, whereas *perceived ease of use* means how effortless does a user believe using a system is. When use is voluntary, user acceptance predicts how much an individual will use the IS in future.

However, if the use of an IS is mandatory, like often in working life, the amount of use depends on three factors: how much an individual wants to follow the order, how much organization emphasizes obligatoriness of use, and on individual variation in the relationship towards technology (Rawstorne et al., 2000). It has been found, that mandatory users' acceptance differs from the cases where use of an IS is voluntary. The meaning of attitudes toward using is emphasized when the use is mandatory (Brown et al., 2002).

Despite the fact that users may be obliged to use the system to carry out their jobs, user acceptance is still worth paying attention to. Albeit the IS is used, the dissatisfaction can impair work satisfaction and atmosphere in work, relations to managers, and loyalty toward organisation (Brown et al., 2002). At workplaces management can support and encourage users to adopt an IS. By providing users opportunities to gain positive user experiences, opinions about the IS can be improved (Henry & Stone, 1995).

Ageing users of information systems

The effects of *ageing* start to show at the age of 45, but the ageing is a very heterogeneous group from their characteristics as a user of technology (Gregor et al., 2002). In this paper we categorize people who are 50 years or older to the group of ageing workers.

According to previous studies, the single most significant factor that makes older users differ from younger ones is the amount of previous experiences with information technology (Tilley, 2003). At present, there are not yet aged people who have grown up with computers. This puts ageing users at a disadvantage compared to young users when they begin to learn how to use a new software or application. However, these age differences in computer task performances may be reduced by offering enough learning opportunities and time for older users (Czaja, 1997).

Although the meaning of growing up surrounded by technology is important in explaining how ageing users differ from younger users there are some age-related changes that alter the user experience. The main physiological differences that older people have compared to younger ones are decrease in the ability to make swift and sharp movements (Hitchcock, Lockyer, Cook & Quigley, 2001). Especially lack of control of pinpoint finger movements may cause difficulties when computer user needs to use a pointing device to choose a small object or

object placed near to others. Also progressive weakening of sight – especially hyperopia, seeing small details, and distinguishing shades – can bother computer work (Hawthorne, 2000). Other changes that come with ageing are for example increase in reaction time, decrease in ability to share attention between simultaneous tasks, and weakening of working memory (Jorge, 2001; Czaja, 1997). It is also worth remembering that ageing doesn't cease, but these changes are in constant alteration in both amount and in nature (Zajicek, 2005).

There are many findings and guidelines to help designing information systems that are usable also to older users (see e.g. Czaja, 1997; Hawthorne, 2000; Zajicek, 2005). The existing studies suggest that diminishing the differences between younger and older users is possible, if the needs of the ageing are catered for when designing functionality and user interface of applications and devices. This kind of usability engineering provides workers better possibilities to ascend at their career and work longer if they want to.

Method

The studied system was used by the Finnish police. At the time of the study, the new graphic data input interface had been introduced to the users of the system. The study was executed to find out how the users regarded the graphical user interface, what kind of usability problems they had encountered, and especially if there were differences between older and younger users.

The study was carried out in two parts. A pilot study consisted of interviewing and videotaping the participants at performing tasks with the IS. On the basis of the results of the pilot study, the questionnaire was formed and sent electronically to the users of the IS.

Pilot study

The pilot study comprised of collecting three different kinds of data from each participant: interview, sketch of user's workflow, and thinking aloud while performing a task using the IS. Data collecting took place in users' workplaces.

On the basis of job descriptions, users of the IS were divided into five categories: inspector, investigator, secretary of investigation, warden, and receptionist of reports of an offence. Four users representing these categories were selected – one of them had worked in two of the categories represented. Age of the participants differed from 47 to 54 years. One of the participants was a female, other were males. Interviews were carried out in two different police districts in Northern Finland.

Firstly the participants signed information consent, and then they were interviewed. The opening questions of the interview concerned users' background information, their amount of computer experience, how much they had used the

previous, text-based user interface of the IS, and how much they had used this new user interface. In order to find out the importance of the system in their work, the participants were asked about the significance of the IS concerning their daily work. Interviews were carried out in a conversational manner and moved on to cover the learning phase of the use of the graphical data input interface. The last question covered what kind of situations participants used the IS and if the situations affected the functionality of the IS.

After the interviewing part, participants were asked to outline how a workflow in a typical instance of use goes, 'thinking aloud' at the same time. Since in the interviewing part had been discussed how the functionality of the IS corresponded to their situations of use, their conception of workflow was already more structured.

Finally the participants were videotaped as they performed on computer some typical tasks from their daily work with the IS. Participants were again encouraged to think aloud while they worked. After performing the task participants were asked some gathering questions about the efficiency of the IS, its good and bad sides, and its appearance.

Data of the pilot study was analysed by transcribing the interviews and examining the videotapes. Grounded Theory (Strauss & Corbin, 1992, 23) was used to find out what features of the IS were relevant for the further studying. Data was examined several times. Concepts that repeatedly came up were collected and categorized. These categories were examined against Nielsen's usability heuristics (Nielsen, 1993) and Technology Acceptance Model (Davis et al., 1989). Language and terms participants used were analysed to better understand the answers from open questions in the survey in the second part of the study.

The pilot study showed us that the users of the IS were heterogeneous in both the tasks they performed with the system, and in features they wished the system should have. The studied IS were considerable large both in functions, data, and number of users. As the result of the pilot study, the most important repeated issues that were usability-related and seemed to affect usability of the system and user satisfaction were classified into eight categories (Table 1).

Table 1. Categories found in the pilot study

Relationship to the use of computers	Previous experience with computers Previous experience with the studied IS Frequency of the use of the studied IS
Instructions	Amount of received instructions Need for more instructions Ease of learning
Ease of use	Ease of use of simple, basic functions Ease of navigation in the IS Consistence between the IS and real world Intelligibility
Minimalist design	Unnecessary acknowledgments Multiple phases on functions Layout of the interface Structure and contents of the screens
Flexibility of use with experienced users	Replacing mouse with shortcuts Automatic filling of form fields Perceived efficiency and flexibility of use
Most disturbing characteristics of the IS	Printing function Inputting data and saving
Errors	Handling errors Error notifications User's feeling of control
Supporting work tasks	Factual content Connections to other ISs Fluency of work with the IS

Survey

After the pilot study, a survey (N=774) was carried out with a questionnaire. The pilot study showed us how a small sample of users used the IS in their working environment and what kind of views they had. Survey was used after the pilot study to attain large number of respondents quickly and effectively (Alreck & Settle 1995, 3).

Categorised concepts from the pilot study gave an outline of what should be asked in the survey, and even some pre-coded questions. The questionnaire was composed of items with Likert scale, open questions, and some statistical questions for gathering background information.

The questions were designed so that each of them was equivalent to one or more of the categories found in the pilot study (table 1). Open questions were used to deepen the quantitative data and to give participants possibilities to respond according to their personal views.

The questionnaire was executed and distributed in electric format. Because the object of the study was an important information system for the authorities, confidentiality agreements were signed. The nature of the IS also restricted the researchers' possibilities as civilians to directly access the IS or collect and transfer data related to it. Therefore the data collection took place in the network of authorities. Information Management Centre of the Finnish Police sent the users of the IS an explanatory e-mail with instructions, informed consent, explanation of these confidentiality arrangements, and a link to the study. The Centre stored the answers and gave the answer files to the researchers for analysis, when the answering period was over.

Results

Demographic information

A total of 798 users of the IS participated in the survey, but 24 were discarded because of missing age information. From the 774 participants 74 % were male and 26 % female. Their age ranged from 21 to 62 years (mean = 39, sd = 10 years). To observe possible differences between different age groups the participants were divided into five age groups (Table 2). Total of 140 participants were on the ageing group of 50 years or older.

Table 2. Categorization of participants according to age

Age group	Lf	%
- 29	172	22
30 – 36	174	23
37 – 42	142	18
43 – 49	146	19
50 +	140	18
Total	774	100

Geographically the answers covered the whole Finland. Participants represented a wide range of assignments. Most common occupational titles were investigator (46 % of all participants), assistant investigator (8 %), inspector (6 %), receptionist (5 %), and office secretary (3 %). Grouping of occupations in the questionnaire was not extensive, because as much as 28 % chose option

“something else”. Respondents had worked in their current post on average 8 years, ranging from 0 to 45 years (SD 8 years).

Relationship to use of computers and the IS

What comes to general experience with computers, majority of respondents considered themselves as experienced (35 %) or rather experienced (44 %), only 1 % saw themselves as completely beginners. Own skills with the IS were estimated a bit lower, but still 17 % answered that they were skilled and 47 % that kept themselves rather skilled. The IS was important and widely used in respondents' work: 48 % used the IS plenty, and 35 % quite plenty.

An interesting description of participants was that ageing and regarding oneself as inexperienced with computers appeared to be connected. Ageing users saw themselves as less experienced than younger users with computers in general. Also in use of the IS, there was a difference between age groups: the older workers considered themselves less experienced than the younger ones (Figure 1).

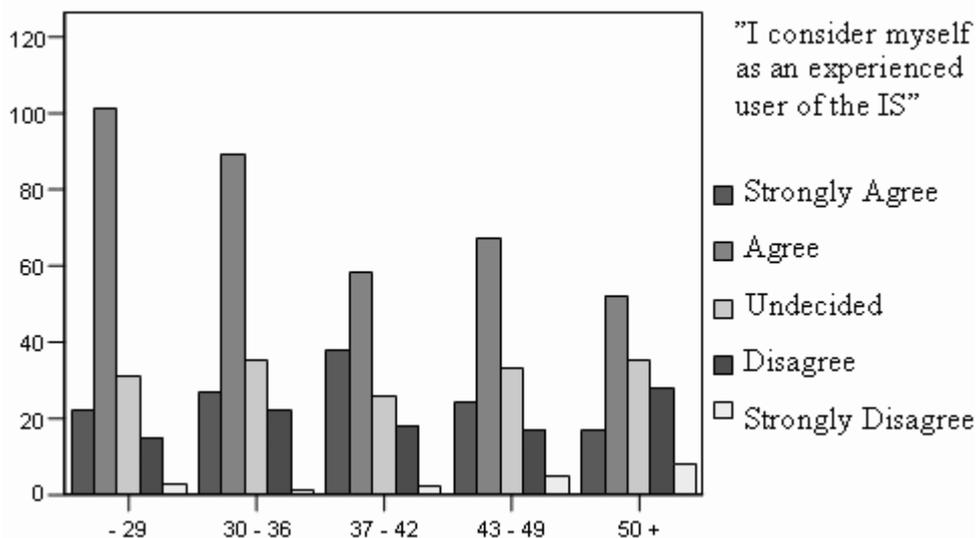


Figure 1. Age and user experience with the IS

Although the ageing respondents had worked longer and quite likely had used police information systems more than the younger participants, they still felt more inexperienced with the studied IS. In addition to general familiarity with technology, this may show that younger workers were faster to learn how to use the new user interface. On the other hand, the difference between age groups might simply tell more about more critical attitudes toward own skills with computers than actual difference in expertise.

User satisfaction towards the IS and earlier computer experience had a weak connection, but the correlation was not statistically significant ($r = 0,037$; $p =$

0,307). This is understandable, because being skilled with computers does not mean that user does not mind usability problems. On the other hand, earlier experience can help to solve problematic situations with the IS. This combined to general interest towards technology can explain the slight connection between earlier experience and user satisfaction.

Age and user satisfaction did have a bit stronger correlation ($r = 0,059$; $p = 0,101$). Younger users were somewhat more satisfied than older users to the IS, but the difference was not statistically significant.

Meaning of instructions in learning to use a new user interface

After introduction of graphical user interface, instructions and teaching were significantly more important to ageing than to other workers. Ageing would have wanted more instructions than what was offered at the beginning of using the IS ($U = 34069$, $p < 0,001$). They also found the learning phase more difficult than younger users ($U = 30793$, $p < 0,001$), and reported to learn the use slower than other age groups ($U = 31715,5$, $p < 0,001$). (Table 3)

Table 3. Age differences in need for teaching and learning to use the IS

	"I would have wanted more instructions when learning to use the IS"	"Learning to use the IS was easy to me"	"I learned to use the IS fast"
Mann-Whitney U	34069,000	30793,000	31715,500
Wilcoxon W	43939,000	232088,000	233010,500
Z	-4,440	-6,313	-5,948
Asymp. Sig. (2-tailed)	,000	,000	,000

A grouping variable: age (50+ years old vs. younger users)

There was a significant correlation between user satisfaction and instructions: user who had had less instructions were more dissatisfied with the system ($r = 0,167$, $p < 0,01$), whereas feeling that learning was easy ($r = 0,281$, $p < 0,01$) and fast ($r = 0,313$, $p < 0,01$) was connected to greater user satisfaction.

Ease of use, navigation, and consistence between the IS and workflow

To the question about if users found basic functions of the system simple to use, there was a definite difference between the age groups. The younger users considered the IS easier to use than the older users ($U = 38221$, $p = 0,005$). As stated earlier, there was no statistically significant difference in user satisfaction between users of different ages, though younger respondents' attitudes toward the

IS were a bit more positive than older users'. Nevertheless, easy of use and user satisfaction were correlated ($r = 0,479$, $p < 0,01$). In consequence we can conclude that even though ageing users don't show significant difference from younger users in what comes to user satisfaction, ageing does affect to the usability problems with the IS. Furthermore, usability is connected to user satisfaction with users of all ages.

There was a slight difference between the age groups in using complex functions ($U = 39719$, $p = 0,042$): the ageing users considered complex functions (and therefore likely functions that are situated deeper in menus) more troublesome to use than the younger users. Instead a question surveying especially navigation in the IS did not show statistically significant difference between age groups ($U = 42754$, $p = 0,476$). (Table 4) So, null hypothesis remains in force: age of users does not affect navigating in the system and discerning the structure of the IS. However, user satisfaction was connected to ease of navigations ($r = 0,477$, $p < 0,01$) and ease of use of more complex functions ($r = 0,487$, $p < 0,01$).

Table 4. Age differences in having control of the structure of the IS

	"Using basic functions is simple"	"Completing complex tasks with the IS is fluent"	"Navigating in the system is easy (e.g. carrying out a specific operation)"
Mann-Whitney U	38221,000	39719,000	42754,500
Wilcoxon W	239516,000	241014,000	244049,500
Z	-2,777	-2,029	-,712
Asymp. Sig. (2-tailed)	,005	,042	,476

A grouping variable: age (50+ years old vs. younger users)

Some examples of problematic parts of the IS:

For example first restraining order inputs were almost impossible to do, because we had no training and nobody could advise me. I still think that we don't do these inputs quite in a way they are supposed to be done, but we can't do them otherwise with this system! - User, 51 years

The whole system is strange to me... - User, 50 years

Using the menus that I seldom use requires consideration. I don't always know what to put in some places. They are open to interpretations. - User, 29 years

Minimalist design

Minimalist design was studied primarily by examining the layout of the IS. Eyesight was the only age-related physical change that was directly asked in the questionnaire. On the other hand, the oldest respondent was only 62 years old, so the age-related changes could be expected to be smaller than if the sample would have consisted older respondents. However, seeing proved to have a clear positive correlation between ageing and problems with eyesight ($r = 0,290$; $p < 0,01$) in the use of the IS which supports the earlier findings. People over 50 had significantly more difficulties with seeing than younger users (Figure 2) – only 6 % of the ageing saw the user interface without any problems. Difficulties with seeing was connected to user satisfaction: those who saw without problems, were more satisfied with the IS ($r = 0,246$, $p < 0,01$). The extent of the problems with the eyesight with the IS was remarkably large considering the familiarity of the problem.

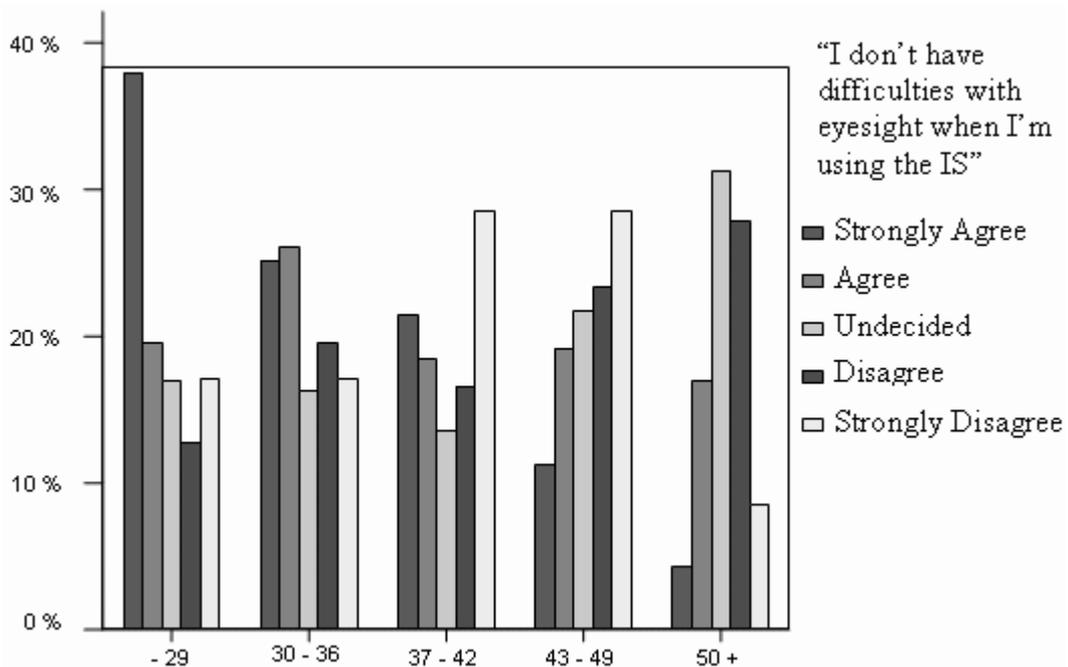


Figure 2. Age and seeing problems when using the IS

Issues related to eyesight were occurred also in open-ended questions:

The font size of the IS should be larger and at this way text should be clearer. After working a full day with the computer, it would be better for eyes to have a clearer and bigger font. Using ground colours could also help. - User, 50 years

Absolutely more VISIBLE text, perhaps larger and darker. And could colouring make a difference, in addition to above-mentioned. - User, 50 years

Errors

Ageing users did face slightly more mistakes than younger participants, but the difference was not statistically significant ($U = 41653, p < 0,233$). Likewise in evading use of the IS by completing the task at hand for example with other information systems ($U = 43892, p = 0,832$) or skipping some tasks wholly ($U = 42031,5, p = 0,308$) there was no significant difference between age groups, though young users shirked from using the IS a bit more than older users. (Table 5)

Table 5. Age differences in making errors and handling them.

	”When I use PATJA there often occurs errors with no obvious reason”	”Error notifications of PATJA are clear”	”I sometimes skip some parts of e.g. data input because of its inconvenience”	”I sometimes evade using the IS by completing the task with other means”
Mann-Whitney U	41653,000	36668,500	42031,500	43892,000
Wilcoxon W	51523,000	46538,500	51901,500	53762,000
Z	-1,194	-3,349	-1,019	-,212
Asymp. Sig. (2-tailed)	,233	,001	,308	,832

A grouping variable: age (50+ years old vs. younger users)

Ageing respondents considered error notifications as less well-defined than younger users ($U = 36668,5, p = 0,001$). This supports the finding about the importance of instructions to older users - also error notifications should help users through problematic situations and advise to a proper way of action. The fourth hypothesis wasn't supported by the data. However, a notable finding was that intelligibility of error notifications was weaker to ageing users than to younger ones. In addition, making errors ($r = -0,294$), evading the use of the IS by using other means to complete the task ($r = -0,310$), and trying to skip the use

wholly in difficult situations ($r = -0,306$) had a distinct negative correlation with user satisfaction ($p < 0,01$). In proportion the intelligibility of error notifications was connected to user satisfaction ($r = 0,298$, $p < 0,01$).

Both older and younger workers had several experiences of errors they didn't understand:

The reason of errors is not clear to **me!** Computer support person often wonders what I have done again! So, as an officer in charge of the investigation I'd better avoid using the IS as much as possible. - User, 54 years

When there's an error in the system, only a notification "application error, creating new error blog" comes up, and the session must be restarted. This notification tells nothing about why there is a error in the system. - User, 38 years

Information disappears strangely. - User, 58 years

Some of respondents were quite certain that it was their fault, not the IS's:

The error is always between a keyboard and an office chair... - User, 55 years

Errors have been caused by my own carelessness and unskilfulness. - User, 56 years

Also avoiding the use was familiar to some of the users:

If it's not absolutely necessary to do something, I gladly skip it. - User, 46 years

Well, if messing around with the IS hasn't tilted the computer, I wrote just with Word the order I have to make. (By this age I have learned to write orders and applications also without the IS!) Usually, at that point, a couple of hours of the working time have gone to these freak-outs. - User, 54 years

Discussion

User satisfaction has been considered both as one dimension of usability (Bevan, 2001; Frøkjær et al., 2000), and as a consequence of usability (Davis et al., 1989; Hassenzahl et al., 2001). Because ageing causes physical and mental changes in humans, ageing person's user experience can be quite different from younger worker's experience. This study aimed at finding out if there are differences in user satisfaction between users of different ages when the use is mandatory, and to what extend possible differences depend on usability of the information system.

The study showed that there were no significant differences between older and younger workers' user satisfaction, although ageing workers faced more usability problems. This supported earlier findings that age does not affect attitudes toward information technology (Kelley et al., 1999). The problems and usability faults users faced had an effect on user satisfaction of users of all ages. We can conclude that good usability benefits all users, but the ageing users benefit from it even more than other.

Neither age nor previous computer experience affected user satisfaction. Though previous experience with computers may help users to cope in error situations, or be a sign of computer as a hobby, the experienced users' attitudes towards the IS were not more positive than beginners' attitudes. The ageing workers reported more often than younger ones being inexperienced with computers and with the IS, albeit they often had used the police information systems longer than the younger workers. This can be explained by the fact that the young have grown surrounded by technology and they might be more confident with technology. Older workers might also be more modest or self-critical in estimating their own skills.

Ageing users' work was notably hampered by the small font size of the user interface. This common and obvious problem could easily be avoided, if adjustability of font size and adequate contrast between background and text would be remembered.

What was contradictory with earlier findings (e.g. Freudenthal, 2001) was that ageing users didn't have substantially more problems with navigation in the IS and deep menu structures compared to younger users. This may be explained by the fact that the oldest respondent was only 62 years old, and the sample was composed of people who were in active working life. Expanding the study to older people could have brought out more evident differences between age groups also in this case.

The results showed a strong correlation between the need for instructions and ageing when new kind of user interface is introduced. Too small amount of instructions might have affected also the fact that ageing users found the basic functions of the IS more difficult to use than younger users. Because ageing respondents of the study regarded themselves as more inexperienced users of the IS than their younger fellow workers, the role of instructions and teaching is very important to them in learning to use a new user interface and managing the IS. The results were consistent with earlier findings about the meaning of instruction for the ageing users. In addition to that, it is worth noticing that teaching has been found to improve user satisfaction among users of all ages (Nelson et al., 1991).

Although ageing users didn't make more errors than others, they found error notifications substantially more unclear than younger users. With fairly minor changes present information systems could be enhanced to help especially ageing users, if error notifications were transfigured to be more clear and instructive.

When considering the generalizability of the results, the strength of the study was a relative large sample (N = 774, with people over 50 years 140). Because the survey was carried out with electric questionnaire, people with the most anti-technology attitudes might have chosen not to respond, what might have biased the results partly. Analysis could also have focused more on the special features of the ageing users, if the study had been designed especially for this purpose – now the main goal of the study was to study general usability and user satisfaction of the system for the client.

Conclusions

The results of the study mainly supported earlier findings about ageing users with IT. The studied IS could be enhanced for all users, but especially older ones, by relatively small changes. Re-design of displays to make font size and contrast between text and background easier to adjust would reduce problems with presbyopia. Revising the error notifications and system's instructions to clearer, easier to understand, and proceeding in stages would help recovering from problematic situations. Also enhancing the quality and amount of teaching and instructions would help ageing users notably (see Czaja, 1997; Kelley, 1999; Tilley, 2003). In further study if these above mentioned enhancements were made, could the differences in user experiences between the younger and the older workers be reevaluated.

References

- Alreck, P. L., and Settle, R. B. (1995). *The survey research handbook*. The Mcgrawn-Hill Companies.
- Bevan, N. (1999). "Quality in use: Meeting user needs for quality", *The journal of systems and software*, vol. 49, no. 1, 89–96.
- Brown, S. A., Massey, A. P., Montoya-Weiss, M. M., and Burkman, J. R. (2002). "Do I really have to? User acceptance of madated technology", *European journal of information systems*, vol. 11 no. 4, 283–295.
- Czaja, S. J. (1997). "Computer technology and the older adult", in M. Helander, T. K. Landauer, and & P. V. Prabhu (eds.) *Handbook of human-computer interaction*, pp. 797–812, Elsevier Science, Amsterdam.
- Davis, F. D. (1989). "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, vol. 13, no. 3, 319–340.
- Davis, F., Bagozzi, R., and Warshaw, P. (1989). "User acceptance of computer technology: A comparison of two thearetical models", *Management science* vol. 35, no. 8, 982-1004 .
- Dixon, S. (2003). "Implications of population ageing for the labour market", *Labour Market Trends*, February 2003,
http://www.statistics.gov.uk/articles/labour_market_trends/Implications_of_population_ageing_feb03.pdf

- Freudenthal, D. (2001). "Age differences in the performance of information retrieval tasks", *Behaviour & information technology*, vol. 20, no. 1, 9-22.
- Gregor, P., Newell, A., and Zajicek, M. (2002). "Designing for dynamic diversity: Interfaces for older people", in *Proceedings of the fifth international ACM conference on Assistive technologies*, 151-156, Edinburgh, Scotland, ACM, New York.
- Hawthorne, D. (2000). "Possible implications of ageing for interface designers", *Interacting with computers*, vol. 12, no. 5, 507-528.
- Henry, J., and Stone, R. (1995). "Computer self-efficacy and outcome expectancy: The effects on the end-user's job satisfaction", *ACM SIGCPR computer personnel*, vol. 16, no. 4, 15-34.
- Hitchcock, D. R., Lockyer, S., Cook, S., and Quigley, C. (2001). "Third age usability and safety - an ergonomics contribution to design", *International journal of human-computer studies*, vol. 55, no. 4, 635-643.
- Jorge, J. A. (2001). "Adaptive tools for the elderly: New devices to cope with age-induced cognitive disabilities", in the *Proceedings of the 2001 EC/NSF workshop on universal accessibility of ubiquitous computing: providing for the elderly*, 66-70, Alcácer do Sal, Portugal, May 2001, ACM, New York.
- Kelley, C. L., Morrell, R. W., Park, D. C., and Mayhorn, C. B. (1999). "Predictors of electronic bulletin board system use in older adults", *Educational gerontology*, vol. 25, no. 1, 19-35.
- Nelson, R., Kattan, M., and Cheney, P. (1991). "An empirical re-examination of the relationship among training, ability, and the acceptance of information technology", in W. Ferrat (ed.) *Proceedings of the 1991 conference on special interest group on computer personnel research annual conference*, 177-189, Athens, Georgia, April 8-10. ACM, New York.
- Nielsen, J. (1993). *Usability engineering*. Academic Press, New York.
- Rawstone, P., Jayasuriya, R., and Caputi, P. (2000). "Issues in predicting and explaining usage behaviours with the technology acceptance model and the theory of planned behaviour when usage is mandatory", in the *Proceedings of the 21st international conference on information systems*, 45-45, Brisbane, Queensland, Australia. Association for Information Systems, Atlanta.
- Rubin, J. (1994). *Handbook of usability testing*. John Wiley and Sons, New York.
- Strauss, A., and Corbin, J. (1991). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publications, Newbury Park.
- Tilley, S. (2003). "Computer documentation for senior citizens", in the *Proceedings of the 21st annual international conference on Documentation*, 143-146, San Francisco, California. ACM, New York.
- Zajicek, M. (2005). "Older adults: Key factors in design", In A. Pirhonen, H. Isomäki, C. Roast, and P. Saariluoma (eds.) *Future interaction design*. London: Springer-Verlag, 151-176.
- Zajicek, M., Wales, R., and Lee, A. (2004). "Speech interaction for older adults", *Universal Access in the Information Society*, vol. 3, no. 2, 122-130.

Requirements Engineering for Software Recontextualization

Dorina Gumm¹ and Monique Janneck²

University of Hamburg, Department of Informatics¹ / Department of Psychology²
gumm@informatik.uni-hamburg.de, monique.janneck@uni-hamburg.de

Abstract. In this paper we propose to broaden the view on requirements engineering by including the *recontextualization* phase when software is actually brought to use in an organization. We argue that by considering the requirements that apply to technology adoption critical problems in software use can be anticipated and prevented. We introduce four case studies where recontextualization problems occurred. By means of the German *Mikropolis Model*, which provides a toolbox for analyzing socio-technical interdependencies, we analyze these case studies and propose guidelines for eliciting recontextualization requirements that can be derived from this.

Keywords. Requirements engineering, recontextualization, socio-technical interdependencies.

1 Introduction

The success of software projects is fragile as it depends not only on process maturity or enough resources but also on project management, micropolitics or the quality of requirements management. Thus, requirements engineering plays a major role for the success of projects (Young, 2001). In addition, a critical phase for software projects is not only the requirements and software development process itself. Also, the phase of introducing and embedding software in a specific context is crucial for software project success (Orlikowski et al. 1995, 1997, Bardram, 1997). In the following we call this phase *recontextualization* (see 2.1).

Requirements engineering provides rich approaches to elicit, analyze and change requirements and to consider the particular working context (e.g. Kotonya & Sommerville 1998). However, the focus in RE lies on software requirements, i.e. what is to be designed (Macaulay 1996). Even in evolutionary software development approaches like STEPS (Floyd 1993), where software development includes software usage and further development, the requirements regarding software's embedding or adoption are only a margin issue.

In this paper, we aim at utilizing requirements engineering concepts for software recontextualization. With this focus, we combine the area of requirements engineering (with the focus on software design) with the area of technology adoption (with the focus on software usage).

For this purpose, we use, on the one hand, the *Mikropolis Model*, which provides a toolbox to analyze interdependencies between software development and usage, the organizational context and the socio-political context. On the other hand, we focus on the requirements elicitation activity. We analyze several case studies by means of the Mikropolis Model to derive a *guideline for recontextualization requirements elicitation*.

The paper is structured as follows: In Section 2 we introduce the Mikropolis Model and basic concepts of requirements engineering on which we base our analysis. Our empirical research data is described in Section 3 and discussed in Section 4. In Section 5 we analyze the data by means of the Mikropolis Model and summarize the results in a guideline. We conclude the paper with a summary and an outlook on future work.

2 Related work

2.1 Mikropolis Model

In their work, Arno Rolf and colleagues argue for considering interdependencies between the information technology development and usage and between organizational structures and society in research as well as in the computer science and informatics education (Krause et al., 2006, Simon et al., 2006). With the *Mikropolis Model* (MM) they provide a framework for identifying and analyzing interdependencies from a variety of perspectives. The Mikropolis Model was originally a didactical approach used in Informatics lectures that is continually expanded to serve as an analytical research tool.

For analyzing socio-technical interrelationships, the framework offers a toolbox of concepts that can be applied from different perspectives. Here, we introduce the concepts of *stakeholders*, *guiding principles*, *formalization gap* and *technology use path*.

These concepts can be used to analyze socio-technical interdependencies from different *perspectives*: The *socio-technical core* represents the underlying reciprocity between software development and the context of usage; the *micro perspective* focuses on interrelationships between different organizational systems; and the *macro perspective* focuses on the interrelationships between the organizations in play and the society in which they are embedded.

Stakeholders

Looking at socio-technical systems makes it inevitable to take an analytical view on stakeholders. Their specific interests, tasks, and activities and the technology used to support them are at the center of the socio-technical system. The MM framework is based on a concept of stakeholders that provides categories that “inform us about the specific abilities, perceptions, and preferences of stakeholders (Simon et al., 2006). Thus, the MM contributes to the stakeholder-focused discussions in the requirements engineering literature (e.g. Macaulay, 1996, Sharp et al., 1999, Coakes and Coakes, 2000, Coughlan and Macredie, 2002).

Guiding Principles

Considering stakeholders one needs to be aware of implicit or explicit guiding principles held by individuals or whole organizations. Guiding principles not only lead development and technology use, but are also often the roots of conflicts herein (Rolf, 1998).

A guiding principle (according to the German term *Leitbild*) is an ideal conception that gives direction to something. A guiding principle is more than a motto or a target goal; rather, it describes a desirable nominal condition by using metaphors.

Formalization Gap

The usage of software is often accompanied by formalized actions that become more set with software support. This can emerge as a critical issue if formalizations reduce or restrict flexibility and marketability (Rolf, 1998). For this reason, the MM provides the concept of a *formalization gap*, which directs attention to the question whether a process should be completely mapped to software procedures or whether a process is intended to provide flexibility.

The MM distinguishes between the *interim* and the *mandatory* formalization gap (Krause et al., 2006): The interim formalization gap comprises routines that are capable of being automated, but whose automation is not yet realized for economical or technical reasons. The mandatory gap comprises activities that are not composed of routines but unique and which can not be processed without a high degree of flexibility. Such activities typically require creativity.

Technology Use Path

The technology use path (TUP) is an analytical tool to analyze the history of technology use and respective decisions. The analysis of such a history allows to identify stakeholders' technology experiences, power structures leading to particular decisions, and arguments for or against a particular technical option (Simon et al., 2006, Rolf et al. 2006). The knowledge of such history helps to understand the given state of software infrastructure and usage in a specific context.

At the socio-technical core the TUP can be used to analyze migration requirements or requirements regarding existing software infrastructure in which the given software needs to be embedded. From the micro perspective one can use the TUP to analyze which software has already been used in a specific context and which stakeholders' experiences are bound to the software and might influence future use of other systems (cf. Finck et al. 2006).

On the macro perspective the TUP illuminates why specific technology has been accepted in society and which alternative paths had not been successful (cf. Ebbinghaus 2005).

Socio-technical Core

The socio-technical core describes the basic reciprocity underlying software development. This reciprocity relates to the interrelating process of a) "formalizing human action and 'translating' it into computer executable routines" (i.e. to detach them from a given context and formalize them with a specific language); and b) "re-embedding those routines into the social context" (Simon et al., 2006). This process comprises on one hand an abstract description of context-specific action – which can be interpreted as a *decontextualization* of action. On the other hand it comprises the transfer of this abstract descriptions (represented by software) back into a particular context – which is called *recontextualization*. With the concept of de- and recontextualization the MM refers to the viewpoint that software development is not only the task of writing correct codes but a task of integrating software development with software's social embedding and adoption (cf. the debate initiated by Dijkstra (Denning, 1989)).

Recontextualization, thus, comprises 1) the implementation of software in a specific context; (2) the preparation of the organization (reorganization) and the software users (training courses); (3) the customization or tailoring of software for a particular context; (4) the adoption of the software for the users' activities; and (5) further development of the software according to recontextualization experiences and new requirements, respectively. However, not all software projects stipulate all aspects of recontextualization. Recontextualization typically comes along with the practice of adoption and usage of software during which software users need to reorganize their activities by adapting their actions to the

software structure or, in turn, by adapting the software usage to their actions. During these processes a variety of conflicts may emerge (Krause et al., 2006).

Using the before-mentioned concepts of stakeholders and guiding principles can help to identify the specific context-related software requirements. The formalization gap may not only help to identify necessary flexibility in software but, possibly, also to identify activities that should not be supported by software at all.

Micro Perspective

The micro perspective focuses on the interplay between the organizations involved in a software development project. Though MM analytically distinguishes between those organizations using and those developing IT (Simon et al., 2006), the analysis can certainly be broadened to a more complex project setting.

From this perspective, one considers the organizational setting and thus, processes of reorganization, pressure of conformity, conflicts between stakeholder groups, among other things. Stakeholders with their interests, motivations, guiding principles, rules and traditions are in the spotlight (Simon et al., 2006, Rolf et al. 2006). Organizational settings and conflicts can influence decisions about software choice, design or usage.

Macro Perspective

The macro perspective, finally, illuminates interrelationships between software development in general and its socio-political context, including economical developments – like market pressure or globalization – as well as political norms, or cultural habit and values (Simon et al., 2006). Software development is influenced by this socio-political context, for example, because particular software projects get financing and others not or because political standards need to be implemented. In turn, software development influences the socio-political context because, for example, specific standards are necessary only because of a particular available technology; or such technology (e.g. the internet) changes cultural communication.

Especially the concepts of stakeholders (or stakeholder groups), guiding principles and technology use path are helpful for analyzing interdependencies from this perspective.

2.2 Requirements Engineering

Requirements engineering (RE) is the sub-discipline of software engineering that involves all activities required to analyze the problem, documenting the resulting observations and checking the accuracy of the understanding gained (Pohl 1993). According to IEEE-610.12 1990, a requirement is a “condition or capability

needed by a user to solve a problem”); a definition that is general enough to also apply to non-software-specific situations (Macaulay 1996). This broad view on RE allows to focus the respective activities not only on a system’s specification but also to the problem context and its understanding.

Requirements elicitation comprises activities to discover requirements in cooperation with customers and users. Results of the elicitation process are, among others, information about the application domain, the understanding of the specific problem to be solved, and the specific needs of system stakeholders. Techniques to achieve these results are, for example, interviews, scenarios, observation and social analysis (Kotonya & Sommerville 1998).

The analysis or verification of requirements aims at discovering problems with the elicited requirements. Goal of the analysis process is to check the requirements (document) against given criteria like, for example, comprehensibility, completeness, ambiguity or testability (Kotonya & Sommerville 1998, Hofmann 2000).

For requirements validation we need to certify the requirements’ consistency with the stakeholders’ intention (Hofmann 2000); thus to make sure that requirements fit to the specific context. Several techniques are available to analyze the context, to connect RE activities with stakeholders’ experience and thus to ease the requirements validation. Such techniques are, for example, use cases (Anton et al., 2001) or prototyping (Jeenicke et al., 2003) to help to feedback development results to users and customers; facilitation techniques to support a close collaboration between development and use context (Macaulay, 1999); scenario based techniques (Galal and Paul, 1999) aim at anticipating future usage and deriving software requirements from that.

In this paper we argue for supplementing such techniques with techniques that focus more on socio-technical problems that accompany software introduction and usage and thus aim at eliciting requirements for – in terms of the Mikropolis Model – software recontextualization. Such techniques should explicitly articulate issues discussed in the MM – which may not unproblematic due to business reasons or interests. We argue further that the appliance of RE activities such as elicitation, analysis and validation may help to consider these issues in a structured way.

In the following we introduce several case studies and analyze them with MM concepts in order to develop a guideline for the elicitation process. This analysis allows to identify typical recontextualization problems and questions that may help to elicit the requirements, respectively. These questions we summarize as a guidelines for recontextualization requirements elicitation.

3 Case Studies

The experience drawn on here comes from a survey on requirements engineering practice. Goal of that survey was to evaluate the interplay between challenges regarding requirements engineering on one hand and organizational constraints on the other one. For that reason, case studies have been selected from a variety of application domains and with different project types. From each case one project participant who worked in the area of requirements engineering was available for expert interviews or group discussions that were analyzed in detail. One of the authors was involved in Case D.

Here we report on four case studies that are listed in Table 1. We first introduce each case by describing the context and some exemplary problems. We discuss them in the following section.

Case	Sector	Product
A	Automobile	knowledge management system
B	Health care	Hospital information system
C	Health care	Dates and Rooms planning system
D	Freelancer	Groupware

Table 1: Overview case studies

3.1 Case A: Software Boycott

Case A involves a large company that consists of one organizational centre and several more or less independently operating peripheral organizational units. One big challenge for this company is the short-cyclic market pressure: The company offers products with very short development cycles which themselves are subject to market pressure. To address this pressure, the peripheral organizational units need to independently generate and use knowledge. Because of the short development cycles and the short validity of knowledge respectively, the knowledge does not reach the organizational centre. Thus, the company's centre required to optimize the knowledge transfer by using a knowledge management system (KMS), where the knowledge of every unit could be stored and retrieved by organizational centre and periphery.

Because of micropolitical circumstances the employees had no interests in expatiating their knowledge with this system. One example: projects of one organizational unit were liable to complicated financial politics; but the employees found possibilities to conduct projects without official financing. However, they were asked to store information about each project commissioning in the KMS; and that in turn meant to expatiate unofficial project financing. This fact was not transparent to the KMS developers; the potential conflicts that may accompany KMS usage were seemingly not taken into account. Finally, the

project failed, because the system had not been used. The KMS was finally removed and a lot of money was lost.

3.2 Case B: Little Nuisances

In case B a hospital aimed at supporting and optimizing the cooperation between different units by a hospital information system (HIS) and thus saving of costs. The HIS supports medical orders and retrieval of communication as well as electronical effort documentation. The hospital used and customized standard software from a large software vendor. The software replaced the previous expensive machine-readable paper-based forms by electronic ones. Hospital units use the software to request medical services from other units, and the service provider unit can document their medical findings in the system. The hospital's IT department selected the HIS software according to the hospital's requirements. The customization of the software included, among others, to map previous forms to the electronic representations and to setup hospital units as medical service providers. During customization, detailed requirements had been elicited and negotiated.

During the software usage different small problems occurred that complicated the activities of the staff. We describe three examples:

While generating an order, specific form entries are always the same. The software unfortunately does not offer the initialization of fields with default values – with more than hundred orders per day a huge expenditure of time for users. As long as this is not mended, such a detail leads to new frustration, and the potential for increasing efficiency remains unused.

The second example is similar, yet opposite in functionality: Here, existing default values that are not replaced by user lead to problems. The form for submitting an order to a specific medical service unit contains a field for a desired date the service should be carried out; the default value is the actual time and date. When not replacing this value, the submitter normally means that the service should be carried out as soon as possible. However, when the form is submitted after closing hour of the target unit one day, the order is not visible anymore on the next day. The software had not offered any feature to make all open orders from the day before visible; a work-around needed to be implemented. (It took the software vendor approximately six years to fix that problem).

The third example is the poor printing functionality. This hampers printing all relevant data for one process in a clear and adaptable layout. For a hospital, a good printing function is essential for proper and lawful file management since the software does not support digital signatures.

3.3 Case C: Personal or Public Appointments

Case C is a sub-project of the HIS adoption project. Aim of this sub-project was to support hospital wide time scheduling and capability planning of health personnel, rooms, medical equipment and medical examinations of patients.

The underlying requirement of the staff was an automation of medical examination planning: The software should be able to fix an appointment when a room is free, medical staff is available and the patient is not undergoing further tests. Software for such a task not only needs to offer a room and equipment management, but also hospital wide schedule planning. The HIS used provides such a module.

However, during the customization of this software module the constraints became apparent: Automation of the appointment finding process requires that in fact all (!) appointments of the entire staff are available. This is problematic for two reasons: First, the maintenance of schedules is very extensive anyway, and the software does not offer any possibilities to synchronize schedules with other calendar software. The staff, however, already uses other calendar systems, software-based as well as paper-based. Thus, a transition period is inevitable, and it is a critical since error-prone phase. Second, the software's functionality for shielding appointments to make the content invisible for others is poor. Such a function is, however, essential for assistant medical directors or head physicians; on one hand they have no report commitment, on the other hand they sometimes have appointments that sound private and thus might lead to wrong opinions and conflicts. One example was a golfing appointment that sounds private but was important for strategic discussions. Because of these problems, the software was not appropriate to support the planning process in the expected extent.

3.4 Case D: Socio-technical pitfalls

Case D is concerned with the development of a groupware system to support a self-organized virtual network of freelancers, founded to exchange experiences, knowledge, and work results, offering its members vocational training and the opportunity to get involved in several occupational working groups or to meet potential clients via the network's contacts.

Even though the software development process was organized as a state-of-the-art participatory design process (cf. Janneck et al. 2006, Janneck & Finck 2006) the resulting software was largely unused or the extent of usage varied greatly in respect to different project settings, respectively.

Thus, a detailed socio-technical analysis was carried out as part of a research project, showing the following problems and phenomena:

- The freelancers had to face a number of changes with regard to their work organization when they started to collaborate within their network, leading to conflicts that interfered with their usage. E.g., they

had different experiences with individual desktop applications that were no longer applicable to a shared web-based workspace, or preferences for different ways of organizing work that had to be negotiated within the network.

- Decisions regarding (past) IT support had seldom been discussed with a substantial number of network members, but rather been made by individual members who were especially competent and interested in IT use. This led to confusion and insecurity within other members regarding the continuity of IT use, reducing their motivation to use the system.
- Analyzing the actors' interests, actions, and motives showed a clear area of conflict between the ideal of equal, non-hierarchical cooperation that was propagated within the network and its actual practices. Decision-making processes were clearly dominated by certain core members, showing hierarchical structures.
- Tensions could be observed concerning the network's main purposes and goals. These purposes varied from mainly social exchange and support to economic interests, such as improved possibilities for acquisition and a stronger market position. An economic orientation, however, raises issues of competition between individual network members, presumably hindering both social exchange and true cooperation. The implicit competition within the network is heightened by the rough economic situation that the freelancers were facing, forcing self-employment upon a number of them in the first place.

4 Discussion of Case Studies

The discussion about the software failure in Case A brought into light that a major problem was the poor differentiation of data, information and knowledge – a critical aspect in the field of knowledge management (Alavi and Leidner, 2001). Apparently, this aspect had not been a concern during requirements engineering or software development: There had not been any discussions about which knowledge could remain in the periphery to maintain their autonomy. The question of which knowledge should be accessible for whom is strongly coupled with power structures in an organization. One project participant considered the loss of power as one major reason for the system boycott. The organizational-wide storage of knowledge brings on knowledge control. The project participant complained that a system that supports such control also supports a tayloristic organization model – a model that suited to the organizational centre but not to the processes in the organizational periphery. The organizational centre aimed at stabilizing their preferred organizational structure by software, but the software failed because of different structures in the periphery.

Thus, we can identify three problems during the recontextualization phase in Case A: First, the discrepancy between control interests of the center and independent modes of action in the periphery had not been considered at all. Second, the usage of software challenged previous power structures and decision power, and a change was not accepted by all employees. Third, the different organizational units had different models and values that the software did not match adequately, which, in turn, hampered the process of embedding the software in the everyday work.

The standard software in Case B could properly reproduce hospital structures and forms but did not provide enough flexibility to map concrete working processes to software features. One main problem refers to the two-edged nature of default values in form fields. In one case, the absence of default values complicated the completion of forms; in another case default values were not updated, making orders ‘disappear’. The software vendor did not take seriously enough such typical problems during the recontextualization of software, and the improvement of the software took several years.

Furthermore, the development of the standard software was seemingly driven by the guiding principle of “paperless office” since the software does not offer a proper printing function. This guiding principle was not considered during requirements engineering, i.e. no requirements were elicited to support such a principle for the target group of hospitals. Respective requirements refer to lawful documentation and digital signatures.

Thus, recontextualization problems in Case B refer on one hand to the sensibility for usability problems and the reinterpretation of software features (in this case: field values); and on the other hand to guiding principles that are not called into question and influence the software design in such a manner that a poor feature causes huge usability shortcomings (in this case: poor printing function).

Ideals are a similar phenomenon to guiding principles and are able to significantly influence software development, implementation and usage. In Case C we find an ideal that it is “good” to provide access to all appointments to everyone. The fact that single persons do not wish to make their appointments public and that in specific situations the appointments’ publishing may evoke conflicts had simply been blinded out.

Similarly in Case D, it could be concluded that the discrepancies between the network’s goals, ideals, and motives on the one hand and their daily practices on the other hand accounted for the low intensity of use that was observed on the network platform: In this vague collaborative setting, concrete occasions and incentives for use were rare. Furthermore, due to the economic pressures the freelancers were facing, it was rather advisable for them to be careful when investing scarce resources such as time and ideas into the network. This especially applies to providing (economically relevant) content to the shared

groupware system. Regarding software support, it had to be checked whether functionalities supporting equal and intense cooperation were truly suitable for the network's needs.

From the discussion we can derive a couple of typical recontextualization problem types:

- Software collides with organizational models and respective organizational structures;
- Guiding principles and ideals of single actors conflict working culture or principles solidified by software;
- Power structures and decision competencies are challenged by new software;
- Organizations are not prepared for new software-immanent concepts;
- Software creates an area of conflict between optimal software usage in a functional meaning and optimal process organization.

In the next section, we will discuss how the Mikropolis Model introduced in section 2 can be utilized to alert software developers to these possible difficulties during the RE phase.

5 Utilizing RE for Recontextualization

Obviously, all of the difficulties discussed in the last section relate to rather implicit factors that are hard to capture and formalize. However, we argue that requirements engineering can and should be done especially for such challenges that relate to the recontextualization process. This goes beyond eliciting context specific requirements; rather, the focus lies on identifying potential socio-technical conflicts that are inherent in software development and usage.

In this section we develop guidelines for eliciting requirements relating to the discussed implicit socio-technical factors by using analytical concepts and tools from the Mikropolis Model.

Considering reciprocity

The Mikropolis Model highlights that the introduction of new technology into an organizational setting always brings about organizational change on different levels: Almost certainly, small, everyday routines will be changed. Workflows will be at least partially altered. Communicational habits might have to be reorganized. And, probably most severely, the organization as a whole might be restructured – e.g. when new technologies lead to streamlining and job loss (see also *On the macro level*, below). All of these aspects could be observed in case D, where freelancers were forced into self-employment because of economic pressures and then joined in virtual networks for mutual support, consequently facing new constraints due to technical, social, and organizational reasons.

These forms of reciprocity are at the very core of the Mikropolis Model: This is what recontextualization is all about. Requirements elicitation with a Mikropolis view accounts for reciprocity issues by asking the following questions throughout the process:

- *What kind of changes on different levels of work organization might occur when the planned technical innovations take effect?* This question might very well be addressed by means of the scenario technique (Carroll et al. 1998, Bødker 2000), particularly by means of plus and minus scenarios.
- *How can the organization be prepared in advance to cope with and benefit from expected changes?* In our point of view, this is seldom addressed by existing RE practices: At the most, instruction and training is offered after new technologies were introduced. What kind of preparation is needed will certainly vary from case to case and might reach from a transparent information policy to restructuring measures and serious negotiations with employee representatives. In any case, the pitfalls identified in minus scenarios (see above) should be addressed. Furthermore, RE can learn from research on appropriation and mediation of technology use (e.g. Orlikowski et al. 1995, 1997), which identified critical stakeholders and processes for making technology adoption successful.
- *In what degree must the software be customizable to adapt to changed and changing organizational needs?* To answer this question it is also helpful to consider the *formalization gap* (see below).

The stakeholders' perspective

Guiding principles, interests and ideals

The Mikropolis Model leads attention to the fact that the involved stakeholders' guiding principles, ideals and interests constitute a powerful impact factor of organizational success. This was impressively demonstrated in case A, where a software boycott by the employees whose interests were infringed upon finally leads to the abandonment of the software system as a whole and a substantial financial loss.

The Mikropolis Model calls for an incorporation of all stakeholders in processes of software and organizational development: The expatiation of ideals that come along with software usage enables an inspection of how they might conflict or support other existing ideals and action patterns. In addition, single functions and features need to be analyzed whether they are needed and desirable organization-wide and, if not, which consequences – for example, job loss, changes of work organization or new work load – a specific software design would entail. In Case C, for example, the expatiation of ideals would have quite

certainly lead to requirements regarding a sophisticated appointments publishing concept.

Ideally, stakeholders are involved in RE processes following Participatory Design methods (e.g. Floyd 1993). However, guiding principles and ideals can be rather implicit and hard to uncover in RE processes. This could be observed in case E, with the freelancers involved in the participatory design processes upholding the ideal of trustful cooperation and negating the problems caused by competition within their network, which also impacted on software usage.

The Mikropolis Model cannot suggest a fool-proof method for eliciting – especially implicit – guiding principles, ideals, and interests. However, it alerts software developers and requirements engineers to be extra careful

- not to exclude stakeholder groups,
- to be sure to make ideals and guiding principles an issue in the RE process,
- to pay attention to nuances and inconsistencies in stakeholders' viewpoints to identify possible pitfalls,
- to be sensitized for conflicts during recontextualization that cannot be avoided but alleviated if expected.

Methodically, a triangulation of data collection methods including methods less prone to social desirability effects (e.g., individual instead of group interviews, anonymous reports and questionnaires, direct observations) is advisable for requirement engineers to get a sophisticated picture of the stakeholders' guiding principles, interests and ideals.

Micropolitical issues

Micropolitics – i.e. actors' strategies to gain influence and power within their institutional and hierarchical framework (Neuberger 1995) – are another tool that is used by the Mikropolis Model to explain and interpret the actions of individuals and groups. For example, in case A employees were not willing to disclose their knowledge to the KMS because they feared negative consequences and limited leeway for future projects. In case D, unofficial hierarchies within the network impacted on the ways technology was adopted and usage was shaped.

Questions to ask during the requirements engineering process to unveil possible difficulties regarding micropolitical issues include:

- Which actors have what kind of power or decision-making authority?
- What needs do the users have regarding the publishing of information and knowledge?
- What impact does the software support of specific power structures have for users and their actions?
- Is a change of power structures through software usage inevitable or even intended? Which consequences may result from this?

Allowing for formalization gaps

RE processes typically strive for a maximum of formalization, i.e., as many details of work organization as possible should be mapped to the software system. In contrast, the Mikropolis Model calls for so-called gaps of formalization: RE should not only identify the processes to be formalized, but also explicitly analyze what not to formalize in order to give the stakeholders enough flexibility for unplanned and unanticipated usage. As case B and C showed, there might be conflicts between ideal software usage (i.e., complete mapping of appointments or re-interpretation of form values) and existing organizational practices. Also, in case B, the software enabled little flexibility regarding its adaptation to actual workflows.

Designing for gaps of formalization brings about a two-fold challenge on requirement engineers:

- They have to design a flexible software system, which can be 'bended' according to users' (emerging) needs;
- they need to be sensible for the limits to formalization throughout the process.

Technology Use Path

Current and future IT usage will be influenced by past experiences with IT systems within an organization: Certain ways of usage that have been coined might be conferred to the new system, even if they're not appropriate, past episodes of technology introduction might have been accompanied by conflicts etc. Tracing the Technology Use Path can reveal potential difficulties rooted in past experiences beyond problems of data migration and integrating new IT within the existing infrastructure.

In case D, for example, we observed a general weariness related to IT support since several attempts to establish a groupware system had failed. This set the new groupware project off for a bad start in the first place. Accounting for this in advance might have convinced software engineers to spend more time building acceptance among the network members well before implementing the system.

Thus, analyzing an organization's Technology Use Path includes questions like:

- What kind of technological support has been used in the past for the task that is to be supported now and for related tasks?
- kind of difficulties and conflicts, but also good experiences were associated with this that might be reproduced by the new technology?
- What kinds of use patterns exist(ed) with past or current technology? How might these patterns interfere with the new technology?
- How was technology introduced to the organization in the past? What worked well, what caused problems?

Adopting a macro perspective

All problems described above can be located on the micro level of the Mikropolis Model, focusing on the interplay between IT and its embedding into organizational contexts. The macro perspective, on the other hand, focuses on the socio-political context in which the organizations are themselves embedded, consisting of social and political norms as well as cultural habits and values and economic pressures in a globalized world.

As case E shows, the macro level has enormous impact on the stakeholders' situation and, as a result, IT usage in the network: For quite a number of network members, outsourcing and job loss were responsible for becoming freelancers in the first place, and the economic pressures they were facing resulted in a competitive situation within the network that impaired a fruitful cooperation and sensible IT usage. For requirement engineers, that means they have to look beyond the horizon of the specific use context and organization they are designing for and take into account its manifold interplay with the outside world.

Figure 1 gives an overview of the analytical tools provided by the Mikropolis Model and examples for lead questions for software engineers to consider during the RE process.

- What kind of changes on different levels of work organization might occur when the planned technical innovations take effect?
- How can the organization be prepared in advance to cope with and benefit from expected changes?
- In what degree must the software be customizable to adapt to changed and changing organizational needs?
- Did you considered all stakeholder groups?
- Were ideals and guiding principles an issue in the RE process?
- Did you pay attention to nuances and inconsistencies in stakeholders' viewpoints to identify possible, pitfalls?
- Did you look for conflicts that may arise during recontextualization that cannot be avoided but alleviated if expected?
- Which actors have what kind of power or decision-making authority?
- What needs do the users have regarding the publishing of information and knowledge?
- What impact does the software support of specific power structures have for users and their actions?
- Is a change of power structures through software usage inevitable or even intended? Which consequences may result from this?

- Is the software system flexible enough to be 'bended' according to users' (emerging) needs?
- Were the limitations of formalization considered?
- What kind of technological support has been used in the past for the task that is to be supported now and for related tasks?
- What kind of difficulties and conflicts, but also good experiences were associated with this that might be reproduced by the new technology?
- What kinds of use patterns exist(ed) with past or current technology? How might these patterns interfere with the new technology?
- How was technology introduced to the organization in the past? What worked well, what caused problems?

Fig. 1: Guidelines for eliciting recontextualization requirements

6 Conclusion

In this paper we used the Mikropolis Model to analyze four case studies of software development with respect to the recontextualization process. The analysis resulted in guidelines for requirements elicitation that can be used to particularly focus on challenges that arise from the socio-technical interrelationship related to recontextualization.

Although recontextualization requirements are already implicitly considered in literature, their explicit elicitation and use for software design is challenging.. Further work is necessary to operationalize requirements engineering for such issues: An investigation should be done how to support analysis and validation of the elicited requirements as well as how to support the implementation of them. First steps are how to identify which requirements can be met by software designs and which by preparing and organizing the process of software embedding and adoption. Future studies could also focus on questions of recontextualization requirements' tracing, change management or verification; or on implications of different project types on recontextualization.

References

- Alavi, M. & Leidner, D. E. (2001), Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues, *MIS Quarterly* 25(1).
- Anton, A. I., Carter, R. A., Dagnino, A., Dempster, J. H., and Siege, D. (2001). Deriving goals from a use-case based requirements specification, *Requirements Engineering*, 6(1):63–73.
- Bardram, J. E. (1997). "i love the system – i just don't use it!". In *Proceedings of the international ACM SIGGROUP conference on Supporting group work: the integration challenge*, ACM Press, pp. 251–260.
- Bødker, S. (2000). Scenarios in user-centred design – setting the stage for reflection and action. *Interacting with Computers*, 13,1, pp. 61-75.

- Carroll, J.M., Rosson, M.B., Koenemann, J. (1998). Requirements Development in Scenario-Based Design. *IEEE Transactions on Software Engineering*, 24, 12.
- Coakes, J. and Coakes, E. (2000). Specifications in context: stakeholders, systems and modelling of conflict, *Requirements Engineering*, 5(2):103–113.
- Coughlan, J. and Macredie, R. D. (2002). Effective communication in requirements elicitation: A comparison of methodologies, *Requirements Engineering*, 7(2):47–60.
- Denning, P. J. (1989). A debate on teaching computing science, *Comm. of the ACM*, 32(12): 1397–1414.
- Ebbinghaus, B. (2005). *Can Path Dependence Explain Institutional Change? Two Approaches Applied to Welfare State Reform*. MPIfG Discussion Paper 05/2, Max Planck Institute for the Study of Societies Cologne March 2005
- Finck, M., Janneck, Mo., Rolf, A. (2006). Techniknutzung zwischen Kooperation und Konkurrenz - eine Analyse von Nutzungsproblemen. In: Lehner, F., Nöhsekabel, H., Kleinschmidt, P. (Hrsg.): *Multikonferenz Wirtschaftsinformatik 2006*, S. 636-376.
- Floyd, C. (1993). STEPS: a methodical approach to PD, *Comm. of the ACM*, 36(6):83–83.
- Galal, G. and Paul, R. (1999). A qualitative scenario approach to managing evolving requirements, *Requirements Engineering*, 4(2):92–102.
- Janneck, M., Finck, M. (2006). Appropriation and Mediation of Technology Use in Stable Self-Organised Online Communities. In: Kommers, P., Isaias, P., and Goikoetxea, A. (eds.): *Web Based Communities 2006: Proceedings of the IADIS International Conference Web Based Communities 2006*, pp. 149-156.
- Janneck, M., Finck, M., and Obendorf, H. (2006). Participatory Design: An Issue for Web-Based Community Development?! In: Kommers, P., Isaias, P., and Goikoetxea, A. (eds.): *Web Based Communities 2006: Proceedings of the IADIS International Conference Web Based Communities 2006*, pp. 274-277.
- Jeenicke, M., Bleek, W.-G., and Klischewski, R. (2003). Revealing web user requirements through e-prototyping, In *Proceedings of the 15th International Conference on Software Engineering and Knowledge Engineering (SEKE'03)*.
- Kotonya, G. and Sommerville, I. (1998). *Requirements Engineering. Processes and Techniques*. Wiley.
- Krause, D., Rolf, A., Christ, M., and Simon, E. (2006) Wissen, wie alles zusammenhangt, *Informatik-Spektrum*, 29(4):263–273.
- Macaulay, L. A. (1996). *Requirements Engineering, Applied Computing*. Springer Verlag London.
- Neuberger, O. (1995). *Mikropolitik: Der alltägliche Aufbau und Einsatz von Macht in Organisationen*. Enke, Stuttgart.
- Orlikowski, W.J., Yates, J., Okamura, K., Fujimoto, M. (1995). Shaping Electronic Communication: The Metastructuring of Technology in the Context of Use. *Organization Science*, 6, 4, pp. 423-444.
- Orlikowski, W.J. and Hofman, J.D. (1997). An Improvisational Model of Change Management: The Case of Groupware Technologies. *Sloan Management Review*, 38, pp. 11-21.
- Rolf, R. (1998). *Grundlagen der Organisations- und Wirtschaftsinformatik*, Springer, Berlin u.a.
- Rolf, A., Janneck, Mo., Finck, M. (2006). Soziotechnische Gestaltung von Freelancer-Netzwerken - Eine exemplarische Analyse mit dem Mikropolis-Modell. In: WISU - Das Wirtschaftsinformatikstudium, Nr. 8-9/06, S. 1089-1095.
- Sharp, H., Finkelstein, A., and Galal, G. (1999). Stakeholder identification in the requirements engineering process, In *Workshop on Requirements Engineering Processes (REP'99)*, pp. 387–391. DEXA'99, Florence, Italy, 1-3 September 1999.
- Simon, E., Janneck, M., and Gumm, D. (2006). Understanding socio-technical change: Towards a multidisciplinary approach, In *Social Informatics: An Information Society for all? In remembrance of Rob Kling, Proceedings of the 7th International Conference Human Choice and Computers*, pp. 469–479. Springer.
- Young, R. R. (2001). *Effective Requirements Practices*. Addison-Wesley.

Implicit Representations of Use: Sources, Potential and Risks

Sampsa Hyysalo

Helsinki Collegium for Advanced Studies

University of Helsinki

Finland

sampsa.hyysalo@helsinki.fi

Abstract. Alongside the explicit requirements-gathering techniques such as market surveys, interviews or field observation, sources of user representation such as cultural maturation of interaction genres and designers' implicit understandings of users have proven important. The present paper gives a brief round up of current research on sources of representations of use. It then continues by analyzing in more detail one source of representation of use—using a designer's own personal experience as a citizen, participant and/or professional—which has been highlighted by a stream of studies during the last two decades. These studies allow also some tentative sketching of the potential shortcomings and risks associated with implicit user representations in IS design. The paper then goes more in-depth to discuss some of the prominent sources for personal experiences in regard to their merits, reliability and limits. It further reviews some of the suggested ways to improve and refine one's experiential basis during a design project and techniques for sharing these insights amongst team members. The paper concludes with drawing implications for IS-research and teaching.

Keywords. Requirements-gathering, representations of use, implicit user representations

Introduction

Explicit requirements-gathering techniques such as market surveys, interviews and field observations are regularly presented as the means by which product and systems design arrives at adequate user requirements and associated

representations of use (e.g. Ulrich & Eppinger, 1995). Current research in the overlapping areas of interaction design (e.g. Cooper, 2004; e.g. Preece *et al.*, 2002), information systems research (e.g. Bødker *et al.*, 2004), technology management (e.g. Leonard, 1995; von Hippel, 2005) and sociology of technology (e.g. Williams *et al.*, 2005) reveals a more complex and multifaceted reality in regard to the representations of use in design than what is found in most text books and standard editions in product and systems development. In short, it reveals how representations of use, users and usages tend to stem from multiple sources, and that there is considerable variation which of these sources provide the most actionable and adequate understandings of use in each particular case. This literature is, however, somewhat scattered across disciplines so that different studies and findings remain detached and their critical impact is thus limited.

With the above in mind, the present paper reviews literature on sources of representations of use in technology design. It argues that explicit requirements-gathering techniques enjoy an overemphasized position in current literature—textbooks in particular. The paper continues by scrutinizing one source of representations of use that has been highlighted by a stream of studies during the last two decades or so, namely using designers' own personal experience. Within this it reviews some of the prominent sources for personal experiences, and illustrates these with findings from a case study of a wrist-worn safety device for the elderly (Hyysalo, 2004), and sometimes also from another well reported case study, that of wrist-top computers for athletes (Kotro, 2005). The paper further examines some ways to improve and refine one's experiential basis during a design project and techniques for sharing these insights with team members, and discusses the potential shortcomings and risks associated with implicit user representations as a basis for IS design.

Sources of user representation alongside requirements elicitation techniques

Explicit requirements-gathering techniques, such as market research, are not the sole or a sufficient source for representing use in design (Akrich, 1995; Oudshoorn *et al.*, 2004; Williams *et al.*, 2005). Designers tend to regard information gathered thus as too unspecific for designing the actual details and too sparse to be used as a sole foundation for the overall design (e.g. Beyer & Holtzblatt, 1998; Cooper, 2004). User centred methods and designers' "emphatic" acquaintance with users' contexts are sometimes used to complement these representations (Beyer & Holtzblatt, 1998; Kuniavsky, 2003), as well as literature searches on previous studies (e.g. evaluation reports) on analogical technologies or user environments. Another source for designing use is the involvement of some users either as hired in-firm experts, or participants in consumer panels and

user-groups (Leonard, 1995; Pollock *et al.*, 2003). Users are sometimes keen enough to act as partners in designing or visioning new products (Bødker *et al.*, 2004; von Hippel, 1988, 2005) as well as to act as testers of early beta and later pilot versions of the technology (Schrage, 2000; von Hippel, 2005).

Designers also use their own experiences as representational of the behavior of users. Using oneself as a reference for the user is common practice, and has been labeled as I-design or Ego-design (Akrich, 1995; Oudshoorn *et al.*, 2004; Russel & Williams, 2002). The in-depth personal experience of doing users' activities, such as climbing or sailing, while designing for these activities, can be a powerful resource (Kotro, 2005). In design discourse common sense and folklore about specific groups of users accompanies—and fills in gaps between—explicit requirements. Generic visions about future (the paperless office, telecommuting) can also function as focusing points and proxies for what users' context will look like by the time the product is launched (cf. Konrad, 2002; Lente, 2000; cf. Lente & Rip, 1998).

Product developers' professional background provides another set of representations of use. An important part of recent research has been a more detailed look at technical visions, engineering traditions and organizational constraints that inform design (Bijker, 1995; Lente & Rip, 1998; Johnson, 2007). Design is conducted with limited resources and heuristics, and pressing schedules, and is affected by organizational divisions of labor, rules, career paths and hierarchies of decision making (Bucciarelli, 1994; Van de Ven *et al.*, 1999). R&D professionals tend to have experience of and ample folklore about use-related issues in previous development projects and implementations. (Johnson, 2007; Hyysalo & Lehenkari, 2005; Hyysalo, 2004; Woolgar, 1991). Notions such as the "average user" can be deployed not only as simplifying gloss (regarded unacceptable in human computer interaction literature), but also as a category that balances out the demands of louder and better articulated groups of users, whose representations of use otherwise configure the designer too much (Johnson, 2007).

Equally important are other R&D priorities and trade-offs. Technical simplicity, reliability, or the cost of manufacturing heavily influence which features are seen as appropriate and desirable, what kind of user interfaces are sought, what the criteria (and points of comparison) for principles and neatness of design and reliability of the systems are. All these create *de facto representations of use* through technical constraints, even though they are not expressed in these terms (Hyysalo, 2006).

Developers' professional background increasingly also includes understanding about usability and human-computer interaction. Whilst a look in HCI textbooks and HCI and interaction design courses suggests that principles from cognitive psychology and usability principles should constitute the major grounding for any decision concerning future usage (Dix, 2004; Saariluoma, 2004), this view appears hopeful at best. In late 1990s and early 2000s studies of over 30

promising European ICT projects revealed that only in a few were user centred methods present and, university research projects aside, virtually nowhere were they used as the key input for designing usage. (Williams et al 2005; Hyppönen, 2004; Miettinen et al 2003). A good example of the state HCI and interaction design in industry comes from a major international Finland based technology company: it has a first class “users and customers” team that had grown to seven people by 2004 and proven its value for the company. However, the company has 5000 employees, a large number of whom work in R&D, and, consequently, the users and customers team regarded its toughest challenges as being choosing which relatively few projects it should get involved in and in which ways to have the most impact (Rekola & Puskala, 2004). Should we want to scale the company size down to a 15 people start-up, it could provocatively be said that the amount of HCI competence in the large company would equal one basics HCI course attended once by one of the designers in such a start-up.

The final key source for representations of use identified thus far is cultural maturation. Technologies build on widespread media and technology genres which are assumed to be familiar to users. Generic genres of prevailing technological culture such as “movie” “telephone call” elements of WWW-navigation or interface using the Windows – Icons – Menus – Pointin device (WIMP) are powerful conventions in bridging design and use. More restricted are digital artifact genres such as automated tiller machine (ATM), an editing program or an instant messaging application (Löwgren & Stolterman, 2004). As generalized appropriation experience, such conventions, images, “grammars” and narrative structures can be trusted by designers to be de-coded in fairly nuanced ways by all those people who have basic competency in a given technological culture. While this cultural stabilization of meanings provides safe ground for variation and experimentation it also sets up limits as to how certain solutions can be understood (Haddon, 2004; Williams et al., 2005, 122-127).

It is noteworthy that all these sources build on experiences and interpretations of design and appropriation of previous artefacts – be these everyday, professional learning or scientific inquiry. The relative adequacy of a given source differs in regard to what kind of constellation between design and use has prevailed, how effective and extensive social learning processes have been to date, and how much the development project at hand differs from earlier ones. While the sufficiency and adequacy of user representations is hard to judge before there are at least prototypes to test the technology in practice, an awareness of their sources and potential biases is useful for a technology project from the concept design onwards.

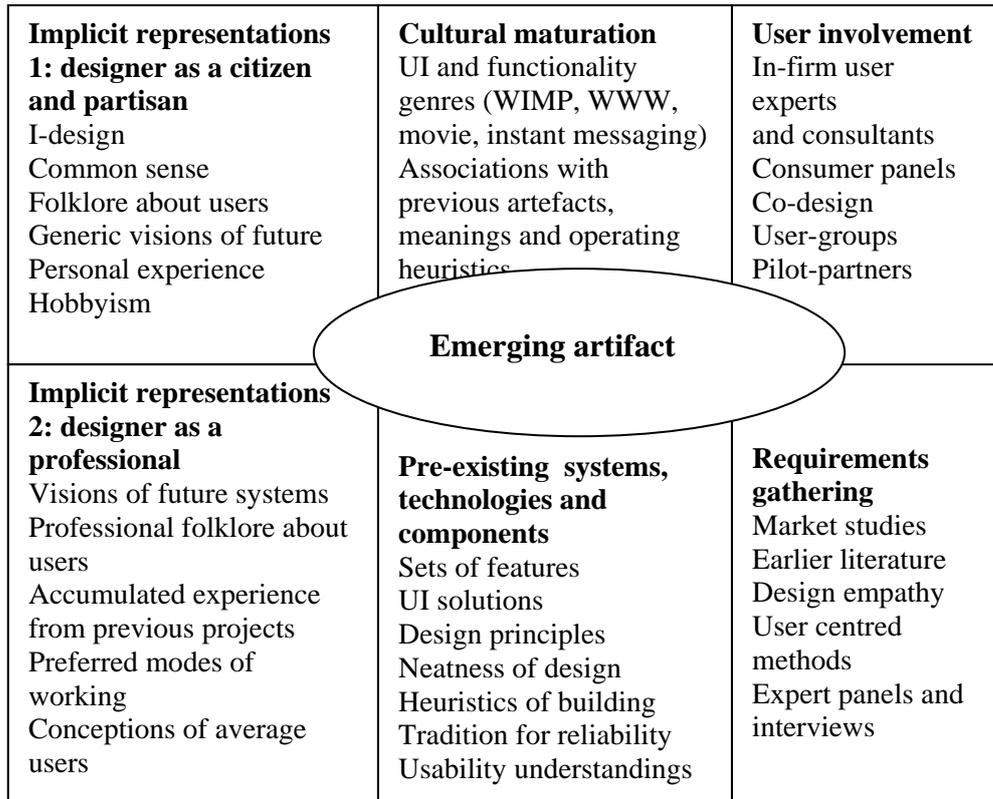


Figure 1. Sources of representations of use in technology design

All in all, mapping the variety of major sources of user representation provides us with a rather different portrait of how users and usages are arrived at during product design than that resulting from formal requirements-gathering (or elicitation) techniques. Indeed, giving each major source of user representation an equal area in graphical representation (figure 1) perhaps provocatively suggests that the future research about requirements-gathering should put relatively least emphasis on the most studied 1/6 of explicit requirements-gathering techniques. Instead, it should take seriously the considerable advances in user involvement in branches such as participatory design (e.g. Bødker et al., 2004; Schuler & Namioka, 1993) and innovation studies (e.g. von Hippel, 2005), and help systemize the work that developers routinely already do in regards to how they analyse and draw insight from pre-existing technologies, components and systems. But even this covers 3/6 of the terrain to be explored. Implicit representations and cultural maturation present important domains that are actively used but grossly neglected in terms of research, theory building and research based advice for developers.

Closer scrutiny of implicit sources of user representation

As noted, ethnographies of design work show that a great deal of use-related design is based on designers' un-explicated assumptions (e.g. Akrich, 1995; Hyysalo, 2004; Oudshoorn et al., 2004). One of the obvious reasons is that it is often unfeasible and unrealistic to ground every solution in gathered user knowledge or testing. Trade-offs and iterative changes add to this reality—even if user research was conducted and used in specification, it is likely that some of the target values need to be adjusted during the design process. The ethnographical analyses of design work support the view that explicated technical problem solving and systematic calculation comprises only a part of design work in engineering and industrial design (Cross, 2000; Löwgren & Stolterman, 2004). The explicit calculation often follows after the complexity is managed through a more intuitive and reflexive exploration of the materials, goals and prerequisites related to the design task (Henderson, 1998; Gedenryd, 1998; Schon, 1983). This is particularly the case with the interface, shape, and feel of technology as well as anticipating how it fits into its contexts of use (Mattelmäki, 2006; Löwgren & Stolterman, 2004).

Personal experience is also a rich source that can be consciously used and refined. A well documented success story about placing confidence in personal experience (Kotro, 2005) illustrates this point well. During the development of Wrist-top computers by Suunto Ltd., the company commissioned market studies, competitor analysis, media coverage, target group analysis and user testing. These created important backgrounds for the design. The most important resources, however, hobbyist knowing about the sports for which the products were designed. Each of the members in the design team had pursued more than one of the sports at pro-amateur level for years and taken together they covered the entire range of sports the Wrist-top computers were meant to be used for. Shared sensitivity to the contexts of use glued together the otherwise somewhat differing perspectives of people from marketing, production, industrial design and engineering. This backbone gave the team, for instance, courage to dramatically alter the course of the project when a new idea emerged in a relatively late stage. The result was a huge success. (Kotro, 2005)

There is also another side to the coin of personal experience. To begin with, such assumptions tend to remain un-explicit. This means that the designer, let alone other team members, has little chance to scrutinise whether the assumptions are fully warranted in all respects. Secondly, we tend to resort to using loose generalizations and one-sided arguments on topics we do not have intimate familiarity with. The fact remains that a brilliant design can falter beyond redemption because of one or a few well-placed shortcomings.

Let us consider another case-study, that of the Wristcare safety device (Hyysalo, 2004). As in the wristtop computer case, market surveys, user interviews and a design study were conducted (albeit on a more modest scale) to chart out user-representations and design solutions. The designers of Wristcare trusted on many occasions their common sense and assumptions about how people would behave with and around the device. The designers did not have personal experience from the life of the users: elderly people and their care givers. The limits of their assumptions became visible once Wristcare was launched to markets. The elderly were in weaker health than expected and their conditions fluctuated more than was prepared for in the algorithms of the device. The nurses faced great difficulties with the control software, which the designers had thought was rather easy. The Wrist-device was worn in a different manner than expected and new procedures and alterations sprung up. On closer scrutiny it turned out that many of the designers' implicit assumptions about usage were influenced by the priorities of production, pricing, delivery and maintenance. Some of these assumptions were known risks and trade-offs; some mere wishful thinking that the designers had not questioned, perhaps due to its convenience for design. The result, however, was that the technology had to be extensively—and expensively—redesigned to create sufficient reliability and usability. (Hyysalo, 2004).

These two examples should make it clear that the adequacy of personal experience, assumptions and visions as a resource for designing usage depends greatly upon the nature of this experience. In terms of likely yield implicit representations provide visions and ideas for design and improved experiential basis for detail design. Participants' experiential knowledge can even function as the foundation on which to build more specific information-gathering techniques. In terms of risks and limitations the haziness, naivety and optimism common to less expert experiential basis comes to the fore. Undue trust can be placed in assumptions derived from personal experience without scrutinizing them with other means. Most use of one's own experiential knowledge tends to remain biased and patchy. Likewise, there are types of applications that require representations that are very hard to formulate on the basis of experiential knowledge alone. For instance CsCw applications have many communication and coordination linkages between the work of different users that go beyond the scope and precision of designers' (or any one user groups') experiential background (e.g. Grudin, 1994; Hyysalo & Lehenkari, 2005).

However, there is more to implicit representations than their generic wholesale strengths and weaknesses or their applicability to particular types of technology projects.

First, it matters greatly what sort of implicit understandings there are. Drawing from extensive familiarity with users' domain is very different to drawing from mere common sense or stereotypes. Even though poorly discussed in handbooks

of product development (IT-development in particular) the adequacy of sources of user representation can be assessed at some depth. Secondly, designer's intuition is not merely a mystical talent which great designers possess and poor designers do not. It can be systematically refined in regard to a particular design assignment. Thirdly, using, sharing and presenting personal experience and assumptions are skills that can be learned and augmented by sets of techniques just as other sorts of user knowledge. These three facets of implicit representations shall be discussed below in this order.

The sources of personal experience and implicit assumptions

The sources of designers' intuition can be analyzed in some detail, which also allows the creation of heuristics for how reliable a given set of assumptions may be. Personal experience has many sources, some of which stand on more solid foundations than others.

Human information processing tends to emphasize some things and suppress others. In particular, we are good at thinking through issues which we are intimately familiar with. But there is a twist: we tend to emphasize issues which we are fluent in and have the means to conceptualize (verbally, visually, and tactilely), and we tend to do that conceptualizing in the manner that we are accustomed to. Our background knowledge thus channels what we tend to think a particular matter is about, how we define the matter to begin with, and what the scope of related matters we are aware of is. Hazier areas are typically believed to find their resolutions as work progresses. While this often is the case, there are few guarantees that designers' experience indeed covers in sufficient detail those facets of the usage of the technology that are most important. In fact, the less we know about some topical area the fewer problems we are able to perceive in it. It is thus far from trivial what sort of experience we lean upon (and are aware of leaning upon).

The most trustworthy source of experience is *personal participation in users' activities* and environments. As in the case of Suunto Wrist-top computers, the designers may have long-term experience in pursuing users' hobbies. Such participation provides a broad and nuanced background as well as grounded visions about technological development of users' practices. The designer is also likely to know what s/he does not know and to have a network of people among users to whom s/he can turn to for further opinions. However, personal participation can deviate from the activities of the targeted users: am I an occasional, regular or highly active member? Do I have strong or biased views about the activity at stake which some or most people may not share? What about

my friends: do they cover the range of orientations of this activity or do they form a similarly oriented subgroup?

A common variety of using personal experience in design is *using oneself as a reference* for how users behave and think, even if one is not a user at all (this is also commonly called I-design or ego design). The reasoning typically goes that there are features in physiology, cognition or action that are common to all people, or will at least be shared among the prospective users and the designer. There are a number of examples of this in the Wristcare case. The first generation control-SW was built to be logical in an MS-Dos environment. This environment was well known for designers but virtually unknown for the nurses and home-care workers. Similarly, a designer used his small children and his own thick wrist to model how much length for adjustment must be built into the wristband of the 2nd generation Wrist-care, as the specifications merely stated that extremely small and large swollen wrist had to be accounted for. This resulted in redesigns later on. On the other hand, the design team relied equally on their intuition in creating a novel kind of push button that was located in a crest to diminish false alarms, but again elevated almost to the top of the device to ease sending off an alarm with a very sensitive button. This proved a success, even though its functioning and diameters were equally drawn from designers' own physiology on the basis of equally vague user representation concerning too many false alarms by accidental hits and difficulties in locating the button at emergencies. These examples illustrate the simultaneous strength and vulnerability of the "I" design when the designers and the users have big differences in, for example lifestyle, age, and education. While it can be a reasonable heuristic, a reality check might be in order: would the eventual users really behave and perceive things like the designers? How do we know this?

It is a safe bet that most technologies have at least some details, probably even features, that have resulted from such reasoning that lumps together the designer and assumed users. There is, after all a formidable history of at least partial failure in designing key features based on such assumptions (for detailed case analyses see e.g. Akrich, 1992; Engeström & Escalante, 1996; Oudshoorn, 2004; Hyysalo, 2004).

Common sense is a close relative to I-design. It can be greatly needed whilst working with complex and esoteric design concepts. But again both the sense as well as its commonness may be seriously misleading. Common sense is characteristically grounded in "everything and nothing"; that is, the totality of designers' living environments, interests and media exposure. At best, it can be close to personal participation and fairly trustworthy. The nasty fact of life is that common sense can be a wonderful aid one moment and lead astray the next. This is in large part because, without us being aware of it, much of our everyday understanding is seriously biased if not entirely mistaken. In our present time much of what we perceive as common sense or natural thinking comes from

various sciences mediated by popularizing media and everyday conversations (Moscovici, 1984, 2001). At work and at dinner table conversations we fluently employ concepts such as subconscious, tonalities, colour scales, limits of working memory and so on. In reality, only a tiny fraction of us know what these concepts actually denote, what assumptions and research has gone into them. (The present author admits ignorance on all accounts despite reading more than one book on each above mentioned topic). When filtered into our everyday, such concepts have typically gone through a major transformation; they tend to have lost modalities (the researcher's cautious "within the domain X we could thus preliminarily assert that explanation y is more likely than z" has become "y is the cause of X") and gone through shifts in meaning and context (Fleck, 1979; Latour & Woolgar, 1986; Miettinen, 2002).

The most misleading part of common sense are *stereotypes*—over-generalizations about group of people or issue. "The elderly avoid latest technology" may indeed be a useful gloss about a general tendency, but it is likely to become a major hindrance in design if it is taken for granted without bothering to dig into more realistic questions such as what sort of elderly people, what sort of technologies and why?

The third important source of assumptions is designer's *professional experience*. Through their professional career industrial designers, engineers, product managers, and marketing people accumulate a stock of opinions and appreciations over what issues are key in product development (Löwgren & Stolterman, 2004; Cross, 2000). Woolgar, (1991) examined how computer designers "configured the user" by building their hardware so that it enforced the norms and actions they wanted the users to comply to. However, such description is in many cases overly rational and falsely portrays designers as potent but malevolent manipulators of users (Stewart & Williams, 2005), as it fails to account for the professional traditions and rationales behind the configuring of use. The Wristcare case gives a more nuanced view of how one's professional background affects designing usage.

In the design of Wristcare the professional practices of designers suggested 'direct' representations of use, such as who the users will be (for instance, healthy and between 60 and 70 years of age), how the device will be used (worn only to trigger acute alarms) and what kind of functionality they preferred (as extensive coverage of physical injuries as possible). The background practices also emphasized other preoccupations that affected how usage became designed. Some matters appeared urgent (such as the maximal coverage of monitoring and cheap production costs) and this had implications about use and users (users must wear the device firmly on their wrists 24 hours a day; all key user-groups appreciate same core functionality and design). These more indirect ways included providing grounds to define the key problems and solutions (for instance, that the challenge with Wristcare was first and foremost technical problem-solving), and means to

seek and assess collaboration in the future (the end-users did not pass the criteria for providers of relevant information). They also included attributions of quality and approval (the medical community could gate-keep new devices until extensive field trials had been performed, but elderly care could not, which made the elderly a better starting point). Furthermore, the professional practices provided a privileged and self-legitimizing perspective into the future development of the practices at stake (the developers saw themselves ahead of the development in elderly care, home electronics and physiological monitoring). Such implicated representations of use remained hard to question, as they were connected to other priorities in design, and also because of the many ways they came about in the process of design. They may pass through design either as “necessary evils” or simply without being noticed, even if merely raising a question about their plausibility would lead to reconsideration about the design concept. (Hyysalo, 2004, 2006).

The Wristcare case also shows that an invention may be significantly influenced by multiple professional traditions, and that these traditions provide designers with assumptions about who the users are, how they shall use the device, and what kinds of functionalities they prefer in the technology. Designers’ varying participations in the traditions of safety phone development; process automation; biomedical paradigms for measuring physiological condition; and elderly care, all provided suggestions about how the design should relate to its prospective use. These traditions contained many kinds of elements that were layered, mutually supporting, but sometimes also contradicting one another. While the assumptions provided by the multiple traditions were important sources for understanding (and misunderstanding) the prospective use, navigating among different priorities and assumptions of users was by no means simple for the designers.

An important variation of professional experience is *strategic vision*. The gut feeling of the R&D manager and the CEOs’ inspiring vision both spring from experience and education. Even when backed by authority their benefits and shortcomings in designing usage are equally dependent on their grounding in other experiential knowledge. It is typical for the technology business to overestimate the impact of the technical innovation on the sales of a new product, and to underestimate the efforts both the designers and users must make before the new product fits the practices of users, and before any significant utility is achieved with it. The boom and bust of Dotcom-companies in the year 2000 illustrated how thousands of companies and investors may ground their operations on such an entirely biased view.

Accumulating and refining personal experiences related to the design domain

Industrial designers use purposeful gathering of experiences and atmospheres as an approach to preparing for a design task. It tunes the designer to central features of users' world, which may be hard to come by other means. It may also provide inspiration for new concepts and understandings of the border conditions that must be respected in the project.

Perhaps the most straightforward way to gain experience for a design task is to *use one's own product, prototype and/or competing products*. Own use gives a good reference point for various issues related to usage (for instance for the way instant messaging systems punctuate work) and things that effect it (the nature of work; the number of other programs that are open; effects of different pointing devices on reacting and adjusting messaging systems; one's position in the team and in the organization et cetera). However, designers' usage is seldom fully representative of that of users. Designers tend to know much more about the system (and also of competitors' systems) than most users ever do. Designers also tend to be more technically experienced than most users, as well as lead a rather different life to that of most users (cf. Nielsen, 1993).

Trying out users' activities—be it work, hobbies or leisure which the design is targeting—can be used to bridge designers' and users' experiences. When IDEO, one of worlds leading design houses got an assignment to re-invent the shopping cart, the first thing its designers did was going shopping...for different families and in different kinds of stores. Whilst gaining personal feel about the activity and environment, they also gained a front row seat into watching how people around them conducted their shopping and handled their carts (Kelley & Littman, 2001). Enhancing personal experience is indeed often a natural companion to field observations.

Issues that are otherwise hard to try out can sometimes be *simulated* by props or by acting. Weakened senses can be simulated by earplugs, out of focus eyeglasses and so on. Poor accessibility is easy to simulate by spending a day in a wheelchair or bandaging stiff a leg or an arm. The manipulability of electronic devices is often simulated by using them with library gloves. Seeking experience and inspiration can be enhanced by augmenting it (perhaps after a more freely experiential period) with systematic attention to the basics of what user experience and users' activities consist of (Kelley & Littman, 2001; Kyttä & Kaaja, 2001; Preece et al., 2002).

The usefulness of personal experience and intuition does have its limits in products targeted for highly specialized people. There is little point in casually trying out pole-vaulting, surgery or even the appointment of a doctor for general practice. The years of training that go into these practices simply cannot be

grasped within a design project. In such cases, it is wiser to try to find *user partners* that can explain and explicate the requirements and key facets of their activities. Also *observing and interviewing* users can give one a good grasp of what they do and what needs to be considered in design. Some combination of these approaches is often a good solution for gaining rich user knowledge for design (Bodger et al, 2004; Hyysalo & Lehenkari, 2005).

The probes-method developed in the University of Art and Design in Helsinki is an example of a method that aims to give the designer an experiential grasp of users' realities in projects where this is hard to achieve. For instance in the project that explored free-ride skiing for outdoors equipment manufacturer, the enthusiasts in the sports were asked to keep a diary, shoot a video, showcase their various pieces of equipment, and to discuss with designers on the basis of this material after the designers had joined them on a skiing trip. The material was then compiled into collages and stories with the aim of giving the designers a rich understanding of the experiential world of the free-ride skiers. Market research, interviews or descriptions would have fallen far short of the understanding that was created this way. Indeed, the Probes studies are a good example of the norm that the best way to gather user knowledge is to find *a combination of approaches* that meets the information needs of the project and suits the intricacies of the users' domain (Jääskö *et al.*, 2003; Mattelmäki, 2006).

Clarifying and sharing user-representations

Experiential knowledge tends to be hard to present and explicate fully. While its richness and multifaceted character makes it valuable, it also tends to remain fuzzy and hard to examine critically both for the person her/himself as well as for the rest of the design team and other associated people. Models, charts, illustrations and prototypes can be used to help explicate assumptions about the emerging product and its users.

The possibility of sharing better and discussing assumptions is one of the key benefits of explications. When relying only on conversations the team members can become convinced of the "shared understanding" they have, whilst in fact most team members think that others share the perspective they happen to hold. On the other hand "shared understanding" as such is an illusion, and moreover, one which is often not very helpful. Design is done in teams precisely because everybody need not be able to do or know everything—for most work it suffices that some of the key knowledge and participant interests gets translated adequately (Bowker & Star, 1999).

There are several different means that are commonly used to crystallize visions and assumptions about a future product, starting from the early stages of concept

design. In many respects these are complementary rather than alternative means because their strongholds are quite different. *Technical specification* can by default be found on almost any technology, and usually also some form of *user requirements* emerges. But skills needed in inferring usage from specifications requires competence that is seldom found outside engineers, while engineers tend not to be the most competent people at figuring out the real life implications for particular users. Moreover, even target specifications tend to emerge quite late in the process and tend to leave open many details for instance in interface design (Beyer & Holtzblatt, 1998; cf. Ulrich & Eppinger, 1995).

Market segments are often used to portray users (Kotler & Armstrong, 2004), but such segments are by default too generic to describe differences between *user groups* (and often re-segmented to guide the design of usage). This is often particularly so in regards to the complex relationships between the buyer, the payer, the user and the secondary users (Kivisaari *et al.*, 1998).

A common shortcoming with all the above widespread techniques is that they tend to remain rather vague in regards to the activities, preferences and environments of users, even their identities. More in-depth explication tools can be found in various IT-design approaches. There basic segmentation exercises based either on entirely implicit representations or on a combination of implicit and explicit requirements-gathering tend to run under various guises. A good example is the de facto segmenting of users into “personas” (Cooper, 2004), that represent user groups by condensing typical segmentation variables (such as demographics of age, sex, place of residence, occupation, income et cetera) and behavioural proxies (such as how they relate to the technology in question, what s/he uses it for, where, under what kind of circumstances and so on). *Scenarios* then condense general facets of usage and its environment into a storyline and the core details of scenarios (usually those that involve the artefact under design) are typically elaborated into *use cases* which describe in detail how the interaction with the technology takes place. (Cooper, 2004; Preece *et al.*, 2002). Various other models of work and systems are equally available in the literature, all having somewhat different application areas, and mostly originally developed for the purposes of modelling data from research (Beyer & Holtzblatt, 1998; Dix *et al.*, 2004; Preece *et al.*, 2002). They can, however, be adapted for tentatively sketching what designers assume the users to be doing, for they can draw attention to what is not known by the team.

The real merit of such explications about usage may however lie in that these can be formed already before the design concept has even really taken shape in order to anchor work (Cooper, 2004). Moreover, additional merits result from refining them throughout the design process. This allows iterative dialogue between the emerging design concept and the understanding of the users, usages and environments of use. It is, after all, a rather rare occurrence that a technology with any measure of complexity emerges successfully from 100% of the

predefined technical solutions that are somehow “made to suit users” or 100% of the wish list gathered from users only to be “realized as such” by technology. The technical possibilities, alternative design avenues, articulation of user needs and the refining of users’ ways of working tend to require further mutual adaptation along the innovation journey (Leonard, 1995; Pollock *et al.*, Forthcoming; Williams *et al.*, 2005).

A notable exception where it makes very little sense to waste time with elaborate explications of who the users are and how they behave are those (usually very stable and discrete) technologies, where both user needs as well as technical solutions can be predicted in full. In such cases the design means merely making a slight variation while copying an existing item—the needed user knowledge is embedded sufficiently in cultural maturation manifest in exemplary artefacts, technology genres and technology specific solutions for creating usability.

Conclusions

The advantages of implicit representations of use and users are obvious in regard to their availability. These are—at least in unexamined and unrefined form—readily available at the beginning of the project. In this facility they help designers to reach quick decisions during the design process and to form a basis for designing applications familiar to designers. In more complex design tasks implicit knowledge is—almost inevitably—an important part in forming a general understanding about users and their environments regardless how apt this happens to be. Here the usefulness of implicit representations hinges on two resources: the time available to think and the skill to use illustrations and models of users, uses and their environments systematically—vital for both sharing and refining assumptions.

All in all, the growing research on using implicit representations offers a reality check on formal methodologies for gathering user-representations, be these technology centred, participatory, or user-centred. It draws attention to everything that happens alongside, even despite of, formal means and methods and emphasizes the work that goes into making those methodologies work efficiently and reliably.

Having said this, the positive contribution coming from the studies on implicit representation is only beginning to form. It has, however, slowly progressed considerably since slogan-like and often normatively laden terms such as I-design or Ego-design, which in the light of the reviewed literature play but a small part of implicit sources of representing use.

References

- Akrich, M. (1992). "The description of technological objects". In W. E. Bijker & J. Law (Eds.), *Shaping technology -- building society: Studies in sociotechnical change* pp. 205-224. Cambridge, MA: MIT Press.
- Akrich, M. (1995). "User representations: Practices, methods and sociology". In A. Rip, T. J. Misa & J. Schot (Eds.), *Managing technology in society, the approach of constructive technology assesment* pp. 167-184. London: Cassel Publishers Ltd.
- Beyer, H., & Holtzblatt, K. (1998). *Contextual design: Defining customer centered systems*. San Francisco: Morgan Kaufmann Publishers.
- Bijker, W. E. (1995). *Of bicycles, bakelites, and bulbs: Toward a theory of sociotechnical change*. Cambridge, MA: MIT Press.
- Bowker, G. C., & Star, S. L. (1999). *Sorting things out: Classification and its consequences*. Cambridge, MA: MIT Press.
- Bucciarelli, L. (1994). *Designing engineers*. Cambridge, MA: MIT Press.
- Bødker, S., Kensing, F., & Simonsen, J. (2004). *Participatory it design - designing for business and workplace realities*. Cambridge, MA: MIT Press.
- Cooper, A. (2004). *Inmates are running the asylum - why high-tech products drive us crazy and how to restore the sanity*. Indiana: Sams.
- Cross, N. (2000). *Engineering design methods - strategies for product design*. Chichester: John Wiley & Sons.
- Dix, A., Finlay, J., Abowd, G. D., & Beale, R. (2004). *Human-computer interaction. Third edition*. Harlow, UK: Pearson Prentice Hall.
- Engeström, Y., & Escalante, V. (1996). "Mundane tool or object of affection? The rise and fall of the postal buddy". In B. Nardi (Ed.), *Context and consciousness. Activity theory and human computer interaction* pp. 325-374. Cambridge, MA: The MIT Press.
- Fleck, L. (1979). *Genesis and development of scientific fact* (F. Bradley & T. J. Trenn, Trans.). Chicago: The University of Chicago Press.
- Gedenryd, H. (1998). *How designers work: Making sense of authentic cognitive activities*. Lund: Lund University Cognitive Studies 75.
- Grudin, J. (1994). "Groupware and social dynamics: Eight challenges for developers". *Communications of the ACM, No 1 January*(37), 93-105.
- Haddon, L. (2004). *Information and communication technologies in everyday life*. Oxford, UK: Berg Publishers.
- Hyysalo, S. (2004). *Uses of innovation. Wristcare in the practices of engineers and elderly*. Helsinki: Helsinki University Press.
- Hyysalo, S. (2006). "Practice bound imaginaries in automating the safety of the elderly". *Social Studies of Science, 36*(4), 599-626.
- Hyysalo, S., & Lehenkari, J. (2005). "Instrument-oriented history, ethnography and interventions in studying is design". In Y. Engeström, G. Ruckriem & J. Lompscher (Eds.), *Putting activity theory to work - developmental work research* pp. 149-172. Berlin: Lehmann Media.
- Hyppönen, H. (2004). *Tekniikka kehittyy, kehittyvätkö palvelut? Tapaustutkimus kotipalvelujen kehittymisestä teknologiahankkeessa. (technology develops, do the services develop? A case study about the development of home-care services in a technology project)*. Helsinki: Stakes.
- Johnson, M. (2007). "Unscrambling the "average user" of habbo hotel". *Human Technology, 3*(2), 127-153.

- Jääskö, V., Mattelmäki, T., & Ylirisku, S. (2003). "The scene of experience". In L. Haddon, E. Mante-Meijer, B. Sapio, K.-H. Kommonen, L. Fortunati & A. Kant (Eds.), *Proceedings of god, bad, and the irrelevant 3-5.9.2003* pp. 341-346. Helsinki: University of Art and Design Helsinki.
- Kelley, T., & Littman, J. (2001). *The art of innovation - lessons in creativity from ideo, america's leading design firm*. New York: Doubleday, Random House.
- Kivisaari, S., Kortelainen, S., & Saranummi, N. (1998). *Terveystuotteen markkinoille. Tuotekonseptista markkinoille*. Helsinki: Tekes.
- Konrad, K. (2002). "Changing agendas in the ict-sector: Direct and indirect orientation of actors and projects by collective anticipations". *Paper presented in EASST 2002 responsibility under uncertainty 31 of July - 3 August 2002, York, England*.
- Kotler, P., & Armstrong, G. (2004). *Principles of marketing 10th edition*. Upper saddle river, NJ: Prentice Hall.
- Kotro, T. (2005). *Hobbyist knowing in product development - desirable objects and passion for sports in suunto corporation. Academic dissertation*. Helsinki: National Consumer Research Center and University of Art and Design Helsinki.
- Kuniavsky, M. (2003). *Observing the user experience. A practitioner's guide to user research*. San Francisco: Morgan Kaufman Publishers.
- Löwgren, J., & Stolterman, E. (2004). *Thoughtful interaction design. A design perspective on information technology*. Cambridge, MA: MIT Press.
- Kyttä, M., & Kaaja, M. (Eds.). (2001). *Vuorovaikutteisen suunnittelun ja ympäristön tutkimuksen metodipaketti*. Espoo: Yhdiskuntasuunnittelun tutkimus ja koulutuskeskus YTK.
- Latour, B., & Woolgar, S. (1986). *Laboratory life: The social construction of scientific facts, 2nd ed.* Beverly Hills: Sage Publications.
- Lente, H. v. (2000). "Forceful futures: From performativity to prehension". In N. Brown, B. Rappert & A. Webster (Eds.), *Contested futures: A sociology of prospective techno-science* pp. 43-64. Aldershot: Ashgate.
- Lente, H. v., & Rip, A. (1998). "Expectations in technological developments: An example of prospective structures to be filled in by agency". In C. Disco & B. v. d. Meulen (Eds.), *Getting new technologies together: Studies in making sociotechnical order* pp. 203-229. Berlin: Walter de Gruyter.
- Leonard, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Boston, MA: Harvard Business School Press.
- Mattelmäki, T. (2006). *Design Probes*. Helsinki: University of Art and Design Helsinki.
- Miettinen, R. (2002). *National innovation system: Scientific concept or political rhetoric*. Helsinki: Edita.
- Miettinen, R., Hyysalo, S., Lehenkari, J., & Hasu, M. (2003). *Tuotteesta työvälineeksi? Uudet teknologiat terveydenhuollossa (from product to a tool? New technologies in health care)*. Helsinki: Stakes.
- Moscovici, S. (1984). "The myth of a lonely paradigm: A rejoinder". *Social Research*, 51(4), 939-967.
- Moscovici, S. (2001). *Social representations. Explorations in social psychology*. New York: New York University Press.
- Oudshoorn, N., Rommes, E., & Stienstra, M. (2004). "Configuring the user as everybody: Gender and design in information and communication technologies". *Science, Technology & Human Values*, 29(1), 30-63.

- Pollock, N., Williams, R., & D'Adderio, L. (Forthcoming). "Global software and its provenance: Generification work in the production of organizational software packages". *Social Studies of Science*.
- Pollock, N., Williams, R., & Procter, R. (2003). "Fitting standard software packages to non-standard organizations: The 'biography' of an enterprise-wide system". *Technology Analysis & Strategic Management*, 15(3), 317-331.
- Preece, J., Rogers, Y., & Sharp, H. (2002). *Interaction design - beyond human computer interaction*. Hoboken, NJ: John Wiley & Sons.
- Rekola, S., & Puskala, A. (2004). *Kone-case - esitys asiakas ja käyttäjätutkimuksen hyödyntämisen tavat proomu-vuosiseminaarin työryhmässä 1.4.2004*. Paper presented at the ProAktiivinen muotoilu ohjelman vuosiseminaari, Hämeenlinna.
- Russel, S., & Williams, R. (2002). "Concepts, spaces and tools for action? Exploring the policy potential of the social shaping perspective". In K. Sorensen & R. Williams (Eds.), *Shaping technology, guiding policy: Concepts, spaces and tools* pp. 133-154. Cheltenham, UK: Edward Elgar.
- Saariluoma, P. (2004). *Käyttäjäpsykologia*. Helsinki: WSOY.
- Schrage, M. (2000). *Serious play - how the world's best companies simulate to innovate*. Boston, MA: Harvard business school press.
- Schuler, D., & Namioka, A. (Eds.). (1993). *Participatory design: Principles and practices*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Schon, D. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- Stewart, J., & Williams, R. (2005). "The wrong trousers? Beyond the design fallacy: Social learning and the user ". In H. Rohrer (Ed.), *User involvement in innovation processes. Strategies and limitations from a socio-technical perspective*. Munich: Profil-Verlag.
- Ulrich, K. T., & Eppinger, S. D. (1995). *Product design and development*. New York: McGraw-Hill, Inc.
- Van de Ven, A. H., Polley, D. E., Garud, R., & Venkataraman, S. (1999). *The innovation journey*. Oxford: Oxford University Press.
- Williams, R., Slack, R., & Stewart, J. (2005). *Social learning in technological innovation - experimenting with information and communication technologies*. Cheltenham: Edgar Algar Publishing.
- von Hippel, E. (1988). *The sources of innovation*. New York: Oxford University Press.
- von Hippel, E. (2005). *Democratizing innovation*. Cambridge, MA: MIT Press.
- Woolgar, S. (1991). "Configuring the user: The case of usability trials". In J. Law (Ed.), *A sociology of monsters: Essays on power, technology, and domination*. London: Routledge.

Software Development Methods And Knowledge Sharing

Sari Vesiluoma

Teleca AB

sari.vesiluoma@teleca.com

Abstract. Knowledge sharing, and especially the lack of it, is one of the root causes for many problems in software engineering work. After analyzing several practical problem situations the author's interest rose to analyze how different software development methods might support knowledge sharing. Here, the knowledge sharing aspects of selected methods has been studied. A Knowledge Sharing Framework, developed by the author, has been used as a comparison framework. One of the outcomes has been the KSF profiles of the selected methods. Those show clearly how three software development methods representing three software development approaches have very different perspectives to knowledge sharing. The biggest challenges are in how to support knowledge sharing inside an organization.

Keywords. Knowledge Management, IS Development, Software Engineering, Agile, Product Line.

Introduction

Knowledge management has been studied extensively, and some research has also been undertaken in the context of software engineering (e.g. IEEE, 2002 and Aurum et al., 2003). Software engineering is one of the most knowledge intensive professions (Handzic, 2003). Due to inadequate knowledge management, many software development organizations face problems identifying the content, location, and use of their knowledge (Rus and Lindvall, 2002). Improved use of knowledge is the basic motivation for applying knowledge management in software engineering. As noted by Turner and Makhija (2006), the issues associated with knowledge sharing have received little systematic attention

compared to the knowledge acquisition issues. Here, the focus is on knowledge sharing.

Knowledge is defined here as something people justify as true (Nonaka 1994), is useful for them in a certain context (i.e. situation dependent, Blackler 1995), and has both tacit and explicit¹ dimension (Polanyi 1966). Also here it is recognized that the knowledge possessed by a person, group or organization develops continuously (Blackler 1995) based on the new knowledge gained.

To define what knowledge sharing means, the theory of Boland and Tenkasi (1995) is used here. They define that a knowledge intensive company relies on multiple specialties and knowledge disciplines to achieve their objectives. A community of knowing is defined to be a community of specialized knowledge workers. A knowledge intensive company consists of several of these overlapping communities of knowing.

The basis for knowledge sharing within and between communities of knowing is the process of perspective making and perspective taking. With perspective making, Boland and Tenkasi (1995) mean the process where a community of knowing develops and strengthens its own knowledge domain and practices. With perspective taking, they mean the communication required for taking the knowledge of other communities into account. In this study, knowledge sharing is defined to be this process of perspective making and perspective taking.

An important question would be, why knowledge sharing does not take place (e.g. cognitive and motivational factors, Hinds and Pfeffer, 2003), but before it can be studied, it is important to define where knowledge sharing should exist. Here, the focus has been on studying how three representative software engineering methods support knowledge sharing. The aim is to understand the differences of these methods with respect to knowledge sharing, and the reasons for these differences. It is expected that in this way the role of knowledge sharing in software engineering in general can be better understood, deficiencies identified in knowledge sharing, and later techniques proposed to improve software development practices by knowledge sharing. This will be studied with a Knowledge Sharing Framework (Vesiluoma, 2007) defined by the author.

All software engineering methods include some kind of a knowledge sharing viewpoint, in some cases more explicit than in others. It would be interesting to study software development methods in practice. However, in practice the methods are always somehow tailored to suit the environment of a company. Because of that, studying the methods in practice could result in a question in which really is studied. As a result, methods are here studied at the theoretical level, as a conceptual-analytical study (Järvinen, 2001, pp. 17-33). Three mainstream software development approaches: traditional, agile and product line

¹ Explicit knowledge is codified knowledge which can be transferred in the form of a systematic language. Tacit knowledge then has a personal quality and is deeply rooted in action, commitment and involvement in a specific context. (Polanyi 1966).

based development have been selected as targets. Used examples of those have been OMT++ (Jaaksi et al., 1999) for traditional, Extreme Programming (XP, Beck, 2000) for agile, and FAST (Weiss and Lai, 1999) for product line based approach.

The rest of this paper is organized as follows. Next section introduces the Knowledge Sharing Framework. The selected software development methods are introduced after that. Fourth section then concentrates on to find what kind of knowledge sharing each method supports, and to summarize the methods utilizing the Knowledge Sharing Framework. The final section provides the conclusions and ideas for future work.

Knowledge Sharing Framework

The knowledge sharing approach of software engineering methods is studied utilizing the Knowledge Sharing Framework (KSF) defined by the author (Vesiluoma, 2007). The target of the KSF is to identify activities and situations which have potential to give rise to knowledge sharing.

KSF consists of three dimensions (see Table 1). Those are: knowledge sharing interfaces, software engineering elements and the project life cycle dimension.

Table 1. The dimensions of the Knowledge Sharing Framework.

Dimensions	Interface (I)	Software Engineering (S)	Project Life Cycle (L)
Elements	I1 In a project team	S1 Managing	L1 Establishment
	I2 In an organization	S2 Value Adding	L2 Realization
	I2.1 Btw current projects	S3 Verifying	L3 Closure
	I2.2 From previous to future projects		
	I2.3 Btw a project and the base organization		
	I3 In Customer Supplier Relationship		
	I4 Unofficial Knowledge Sharing		

Knowledge sharing, the process of perspective making and taking, is studied here in a software engineering environment. Most software engineering work is organized as projects and is implemented in project companies. A project company consists of company structures and project structures (Artto 1998). A project company has, according to Gareis (1996), a lean base organization and a variable portfolio of projects. In Figure 1, a structure of a project company is described. It is based on the general dichotomy: base organization and projects. The base organization consists of line management, resource pool and support

functions. Based on the situation, a variable number of projects exist in different phases of their life cycle. Every project has its own project team, which consists of persons from the company's resource pool and perhaps from suppliers' and/or customer's personnel.

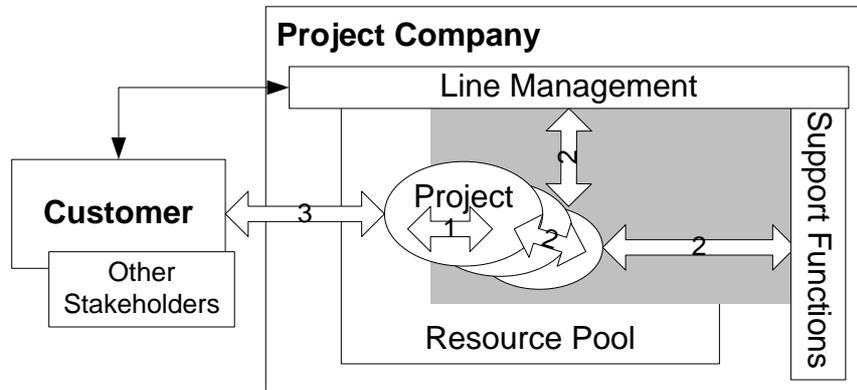


Figure 1. Structure of a project company.

Knowledge sharing takes place between stakeholders, or according to Boland and Tenkasi (1995), between communities of knowing. When knowledge sharing happens or should happen between certain stakeholders, here, it is defined that there is a knowledge sharing interface between these stakeholders.

The stakeholders in this context are individuals, project teams, base organization, customers and other stakeholders. Based on these, different knowledge sharing interfaces in software engineering can be defined (Figure 1): 1. between the individuals in the project team, 2. between the project team and the rest of the organization including other projects, and 3. between companies (a company and its customers, suppliers and other related parties). The interface between companies has been applied here to customer communication.

In addition to these more formal knowledge sharing interfaces, there is a lot of unofficial knowledge sharing between individuals. This means all situations where an individual is sharing knowledge or communicating with another individual, for example, based on friendships. This can happen at any interface.

Some kinds of software engineering elements were required in addition to these interfaces. Not to follow e.g. the waterfall (Royce, 1970) type of division which would limit the scope to traditional methods, the following elements were selected: S1 Managing, S2 Value Adding, and S3 Verifying software engineering. The last two elements are introduced by Kylmäkoski (2006). According to him, value adding software engineering is that part of a project where new results are gained and the progress is achieved. It should not be distinguished with Boehm's Value Based Software Engineering (Boehm 2006) despite the apparent similarity in their names.

Verifying software engineering means the activities that are required to assure that the results from the value adding actions are the ones wanted and carrying good quality. In addition to the value adding and verifying elements defined by Kylmäkoski (2006), also an element is required for managing the work. It is required especially because software engineering work is team work requiring coordination.

Dimension L then follows the project life cycle including establishment of a project, project realization and closure. From knowledge sharing perspective, a project has two very critical phases regarding knowledge sharing, the beginning of a project and the closure of a project. In the beginning (here called establishment) it is critical to make sure that all required knowledge is adequately available for a project in the form of people, documents, requirements etc. At the project closure, the challenge is to assure that the knowledge gained in the project is properly shared in the organization to the parties needing it or storing otherwise so that it is accessible when required. Practically, the establishment phase means the work required to start a project and to collect the basic set of requirements for it. The project realization is the actual implementation of the project and the project closure is the phase, when the project is officially closed and evaluated.

Software Development Methods

Traditional, agile and product line based software development approaches are the current mainstream approaches to software development. Traditional, or plan driven approach, has its origins in waterfall based (Royce, 1970) thinking. Agile and product line based approaches have been defined after that. Agile has its origin in the problems of traditional software development approach. Software product line approach is based on the idea of systematic reusing. The means for knowledge sharing have been very different in these three approaches making those good candidates to make visible solutions for knowledge sharing in software development work.

One method has been selected to represent each of these three approaches. Those are: OMT++ (traditional), XP (agile) and FAST (product line based). In different kinds of environments different approaches are required. Thus, it is not reasonable to compare whether one method is better than the other. The focus has been here to make explicit the approach to knowledge sharing in the selected methods.

Different software development methods or process models are not coherent entities except collections of methods following general principles of some software development approach. Different software development methods are not totally interchangeable with each other. It means that those can include slightly different entities and those could cover partially different area of the software

development work. The following chapters include short introduction of the selected methods.

OMT++

OMT++ was initially extended from the Object Modeling Technique (OMT, Rumbaugh et al., 1991) but later it has got influence from many other sources. The study of OMT++ is here based on the Jaaksi et al. (1999) book. The main phases of OMT++ are described in Figure 2. It is an object-oriented, plan-driven method producing several documents in addition to the final code.

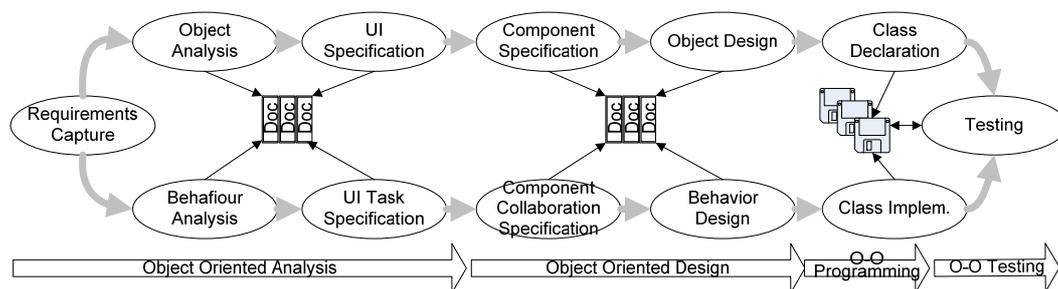


Figure 2. The main phases of OMT++ (Jaaksi et al., 1999, p. 7).

The details of the OMT++ process model are not relevant here. As can be seen in the Figure 2, there are two paths, static (upper path in Figure 2) and functional (lower path). The activities on the static path are aimed to define and implement the structure of the required software. The functional path aims at defining and implementing the collaboration of the static path entities. (Jaaksi et al., 1999, p. 6). When developing more than one application for the same domain the method recommends defining a domain model. A domain model defines the concepts of the domain and the terminology used (Jaaksi et al., 1999, p. 8).

The OMT++ method does not contain many references to the managerial part of software engineering. Only some general thoughts exist. Jaaksi et al. (1999, p.99) states e.g. that when the project team grows the individual productivity decreases dramatically. To help that, an individual needs a *sandbox*, an environment where she can work alone with well-defined dependencies to the sandboxes of others. The work of individuals, especially in bigger projects, shall be guided with a controlled process and architectural models. Processes and architectural models serve as a base for project metrics, project management decisions, quality control checkpoints, and scheduling (Jaaksi et al., 1999, p. 104).

Extreme Programming (XP)

Extreme Programming (XP) (Beck, 2000) is here used as an example of the agile approach.

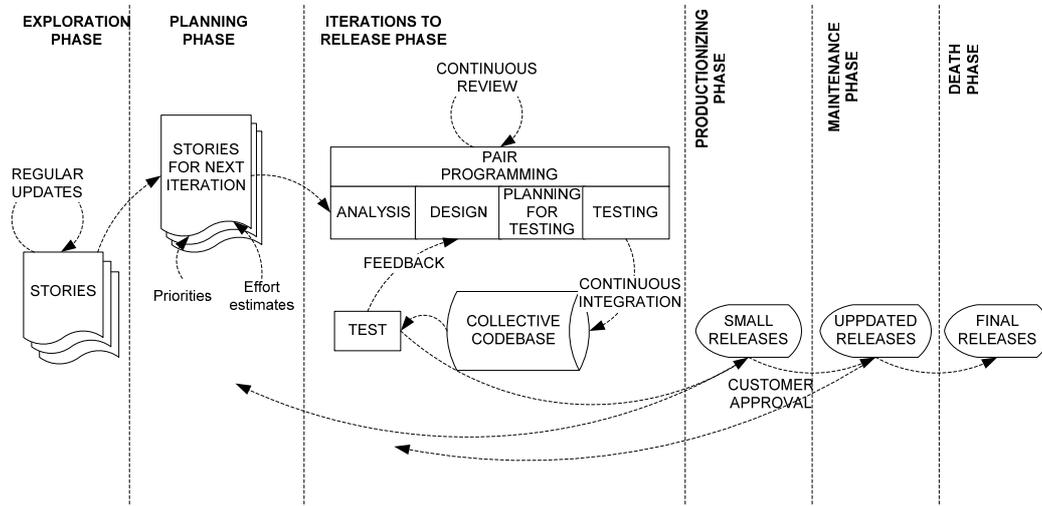


Figure 3. Life cycle of the XP process (Abrahamsson et al. 2002, pp. 19)

Abrahamsson et al. (2002, pp. 19) have made a process model of the life cycle of the XP process (Figure 3) based on the phases defined by Beck (2000). During the exploration phase, the features etc. required by the customer are documented as story cards. This phase is implemented as long as the customer is confident that there are enough story cards to implement a good first release. During this phase there might also be technology explorations and pilots for architectural ideas to have the certainty how to establish system, so that the programmers can make reliable estimates of the effort required. (Beck, 2000, pp. 131-133.)

In the iterations to first release phase the schedule is broken into one to four week iterations. For each of those the stories to be implemented are selected based on the customer's discretion. Iteration results a set of functional test cases for each of the stories scheduled in the iteration. After the implementation of a story, the customer runs the functional tests and the iteration ends to the successful completion of those. The architecture is put in place during the first of the iterations. (Beck, 2000, pp. 133-134.)

After the last iteration the productionizing phase will start. The iteration cycle normally shortens, but the pace at which the software evolves slows down. This phase includes some extra testing, checking and the releasing to the customer. After releasing, starts the maintenance phase. It includes maintaining the software and adding some new features, small releases (using the planning and iteration described earlier). When no new stories are invented and the customer is satisfied

with the system it is time for the death phase including e.g. shortly documenting the system. (Beck, 2000, pp. 134-137.)

The production code is written with two programmers at one machine. In practice this means e.g. that code review is a constant action made in pairs. Another important feature of XP is that before coding, unit tests are made and run (preferably automatically) after writing the code. Customer writes the functional tests which demonstrate that the features are finished. A full-time on-site customer is continuously available as a participant of the project team. (Beck, 2000, pp. 54-61.)

The manager's job in XP is to run the Planning Game², to collect metrics, to make sure metrics are utilized and to intervene only when a situation can't be resolved in a distributed way by the team. (Beck, 2000, p. 74.) The manager is more like a coach and the team more like a self-steering team. The communication of system structure and intent is based on oral communication, tests and source code (Beck, 2000, p. xvii).

FAST

A software product line is according to Clements and Northrop (2002, p. 5):

A set of software-intensive systems sharing a common managed set of features that satisfy the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way.

Software product line could be defined as a production system for software products or a product family based on the core assets. Bosch (2000, pp. 19) says that architecture is the key element to create a paradigm shift from traditional approach. In general, a flexible architecture is a key element of a product line.

² Quick determination of the scope of the next release by combining business priorities and technical estimates (Beck, 2000, p. 54).

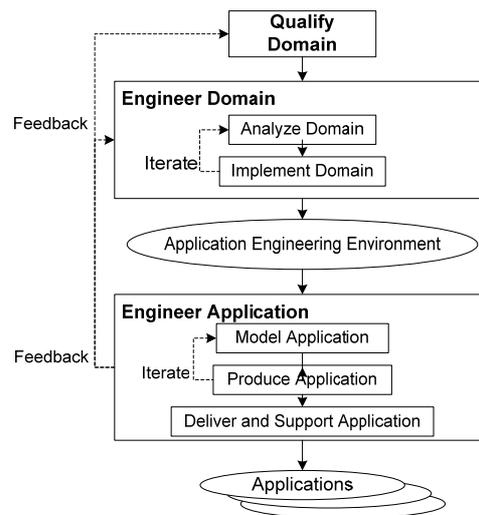


Figure 4. The FAST Process Pattern (Weiss & Lai, 1999, pp. 44).

FAST method, Family-Oriented Abstraction, Specification and Translation Process (Weiss & Lai, 1999) has here been selected as a representative of product line based software development. It includes three sub processes: to identify families worthy of investment (qualifying the domain), to invest in facilities for producing family members (engineering the domain), and to use those facilities to produce family members rapidly (engineering applications) (Weiss & Lai, 1999, p. 43). These can be seen from Figure 4. These all are then further defined with artifacts and production activities in addition to the definitions of organizational roles in the whole production.

After deciding that a domain is economically viable, the domain engineering begins. The purpose of it is to make it possible to generate members of a family (Weiss & Lai, 1999, p. 53), and it results into the application engineering environment. The environment for application engineering includes an application modeling language to describe the family, tools for creating family members and an application engineering process for using the environment to create domain members (Weiss & Lai, 1999, pp. 14-15).

In FAST, the production of family members, applications, is very strictly guided. The purpose of the application engineering is to quickly explore the space of requirements for an application and to generate the application (Weiss & Lai, 1999, p. 49).

Important part of the domain engineering is to create a process model for producing an application. Weiss & Lai (1999, p. 144) have introduced PASTA model as a way to “model complex processes in a graphical, systematic, precise and structured way.” They define the PASTA model to be a communications medium. The resulting process model serves different purposes to different stakeholders. For process designers it is a way to represent the process. For environment developers the model serves as a specification for the environment

they must develop, and for the software developers it serves as a guide for what they must do at each step of producing the application. (Weiss & Lai, 1999, p. 145.)

Knowledge Sharing Approach

Knowledge sharing approach in selected software development methods is here studied according to the KSF. Firstly, the software engineering elements S1-S3 are defined at a very general level, and then the knowledge sharing in defined interfaces is introduced. The unofficial knowledge sharing (I4) is covered only at a very general level, because of its unofficial and unpredictable nature. Finally, the actions including knowledge sharing related to the project life cycle phases are shortly introduced.

After introducing knowledge sharing approach of these three methods separately, a summary is made in the form of KSF profiles and the methods are compared with each other based on these profiles.

OMT++

Nearly all phases of OMT++ are related to S2, value adding software engineering. The only exception is the phase Testing representing S3, verifying software engineering. Quality control checkpoints are referred to and those represent also S3. Managing element S1 is not very visible in this method but some references e.g. to the important role of controlled processes and architecture models could be thought to represent this view to software engineering. To S1 approach belongs also the sandboxes, ways to organize work of individual project team members.

The I1 interface, knowledge sharing in project team, is very much based on the documents and the code, as can be seen from the Figure 2. In practice, the project team members communicate together also using many other ways of communication, but the method does not really much highlight those. Jaaksi et al. (1999, p. 37) say: "Documents contain the blueprints of software development. A group of people cannot develop software without proper documentation." Jaaksi et al. (1999, p. 37) find three purposes for the documents: 1) those provide a visible view to the system in each phase, 2) the documents can be used to document the system and requirements for a later study and 3) the documents form the basis for testing.

The S2, value adding software engineering and the S3, verifying software engineering are mostly implemented in the project team including also some knowledge sharing with the customer (interface I3). The customer relationship and participation of customer representatives is not very visible in the model, but present e.g. in analysis and testing. One exception of this is the introduction of use cases as an important tool for sharing knowledge between the engineers and

the customer (Jaaksi et al., 1999, pp. 12-13). Use cases are used for planning some of the most critical parts of the requirements together with the customer.

The interface inside the organization, I2, is visible e.g. in the reference to domain model. It can be a basis for knowledge sharing between current projects (I2.1) and from previous to future projects (I2.2). This knowledge sharing is based on an artifact (e.g. document) defining the domain model. The method does not have direct references to knowledge sharing between the project and the base organization.

I4, unofficial knowledge sharing, means mostly all kinds of unofficial and informal communication between people. OMT++ emphasizes the importance of e.g. sandboxes and documentation. These approaches could be thought to result isolating the work of single project team members and thus not encouraging to personal contacts. Based on this understanding OMT++ does not much support unofficial knowledge sharing.

Requirements capture phase represents in OMT++ the L1, project establishment. All other phases represent L2, project realization. So, actions requiring strong knowledge sharing exists related to these two but L3, project closure is not included in this method.

XP

In XP, the value adding element (S2) of software engineering is visible in all phases except in the planning phase. Story cards (the requirements for the project), unit test definitions (could be partially compared to design), and the resulting code represent results from value adding software engineering. The verifying element (S3) then is present in testing and in the pair programming, which actually means a continuous code review. Managing software engineering element (S1) is implemented in quite a de-centralized way, in coaching mode and more relying on a self-steering project team.

As Beck (2000, pp. 29-30) says, “Problems with projects can invariably be traced back to somebody not talking to somebody else about something important”. This sentence describes well the point of view of agile methods and especially XP to software development. Direct communication is the most important way of communication. In addition to that, tests and source code are used as tools for communication. These ways of communication apply especially to knowledge sharing interfaces I1 (in project team) and I3 (with the customer). In the I1 interface strong communication and knowledge sharing include all S elements.

Through supporting direct oral communication XP could be thought to support also the informal knowledge sharing (I4). At least, making people communicate more with each other could add to the amount of unofficial communication.

The guidance from the customer (I3) is strong through defining the implementation order of the story cards, and by having on-site-customer in the

project team. The guidance relates to the managing element (S3) of software engineering. The on-site-customer then participates to all of the S-elements. Especially the participation of the customer is strong through the definition and running of functional test cases (S2, verifying software engineering element).

So, interfaces I1 (knowledge sharing in project team) and I3 (with customer) seem to be very active knowledge sharing interfaces. However, the I2, knowledge sharing in organization seems not to be noticed much. Actually Beck (2000, pp. 38) says that “today we need to do good work solving today’s problems and trust our ability to add complexity in the future when needed”. This could be counted as a counterargument e.g. to the reusing based approach of product line based development.

The first phase of XP life cycle, the exploration phase, represents the project life cycle element L1, project establishment. The death phase represents the element L3, project closure.

FAST

Most of the activities described are related to S2, value adding software engineering element. The S3, verifying element is present in e.g. qualifying the domain, validating model etc. S1, the managing element, is present e.g. in the strict guidance given to the whole process and especially to the application engineering phase.

When comparing FAST to OMT++ or XP, here, a new layer is introduced. Domain engineering represents the I2 interface in many ways. Firstly it includes the I2.3 (knowledge sharing between a project and the base organization) while creating the application engineering environment. It could be discussed whether this is a project or a process producing this environment, but let’s define it here as a project renewing the application engineering environment.

The knowledge sharing between the projects (I2.1) mean e.g. communicating required changes from an application engineering project to the domain engineering project. Interface I2.2 (knowledge sharing from previous to future projects) could be defined to include sharing the application engineering environment from the domain engineering project team to the application engineering project teams. It also includes indirect knowledge sharing between application engineering project teams through updating the application engineering environment first by the domain engineering project.

The interface I1, knowledge sharing in project team, means here actually two types of teams, the domain engineering team and the application engineering teams. The method describes well the steps required for the actions in value adding software engineering (S2) in project team, for both the domain engineering and for the application engineering. The knowledge sharing is strongly based on artifacts.

The interface I3, knowledge sharing in customer supplier relationship, is here partially replaced with gaining understanding of the market and financial feasibility of the planned product line. During an application project, the customer requirements are collected and compared to the product line environment.

I4, unofficial knowledge sharing seems to be here quite much similar to OMT++. The importance of documentation and clear responsibility areas is emphasized and no direct communication is really supported. Even between the people doing domain engineering and application engineering the interface consists of artifacts diminishing the need of direct communication. Thus the potential to initiate strong positive unofficial knowledge sharing seems to be very low.

Project life cycle dimension (L) can, with this method, be looked from different perspectives. When studying the domain engineering and application engineering projects as one entity, the L1 element (project establishment) could be defined to mean the whole domain engineering part required to produce the application engineering environment for the application engineering project. Then L2, project realization, would be the implementation of the application engineering projects. L3, project closure, could then be the closing of the product family. The method does not refer much to this part.

The application engineering process and the associated production facility are a result of knowledge capturing (perspective making). Knowledge, known only to a few people, is incorporated into a set of tools that can be widely distributed and used. The application engineering process captures and documents much of domain specific knowledge. (Weiss & Lai, 1999, p. 154.)

Summarizing the Knowledge Sharing Approaches

A KSF profile is a matrix made using the dimensions of the Knowledge Sharing Framework. The KSF profiles of the selected methods are introduced in the Figure 5 and Figure 6. The I4 and the L dimension have been introduced separately without mapping with S dimension. For I4 the mapping with the S dimension was irrelevant and for L dimension it was left out for simplicity.

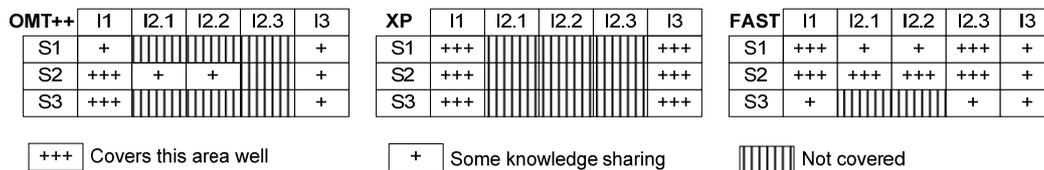


Figure 5. KSF profiles including I and S dimensions.

In OMT++ and FAST, the main way of knowledge sharing seems to be artifact (documents etc.) based and in XP oral communication based. The KSF profile of

XP (Figure 5) differs from the others so that it has really strong knowledge sharing and communication in the customer interface. On the contrary, the interface I2, knowledge sharing in the organization, is practically non-existent. OMT++ has some minor actions related to that area, but FAST has some of its strengths especially in this area and in the utilization of systematic reuse. The I2 element is crucial for organizational learning, thus the lack of this element in a method should be compensated with some additional actions in an organization.

OMT++ concentrates more on the project implementation and knowledge sharing in the project team. Of course, communication with the customer is also present, but no special focus is given to it. The S1 element (managing software engineering) is normally supported with a project management activities taken in addition to the phases of this method. Noticing separate project management activities would make also the profile look slightly different from S1 element perspective.

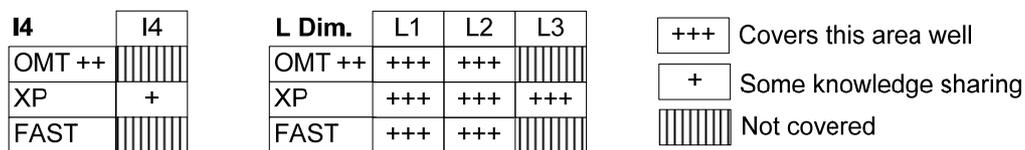


Figure 6. I4 and L dimension of the KSF profiles.

I4, the unofficial knowledge sharing (Figure 6) is not fully supported in any of these methods, but XP could be thought to give more place for direct communication, and thus the emergence of unofficial knowledge sharing. On the contrast, OMT++ and FAST seem more to separate people from each other through emphasizing the importance of explicitly defined artifacts and procedures.

The KSF profiles of OMT++ and XP look rather similar according to the I1-3 elements and the S dimension (Figure 5). In L dimension (project life cycle, Figure 6) the OMT++ does not support knowledge sharing for the project closure (L3) phase. Based on this dimension, OMT++ and FAST have similar kind of profile even though on the other dimensions there are big differences.

A significant difference not visible in the KSF profiles, is the type of knowledge sharing mainly used. In OMT++ and in FAST it is pretty much artifact based when in XP it is mostly based on direct oral communication. This must be noticed in addition to the KSF profiles.

Like noted earlier in this paper, software engineering methods are not directly interchangeable. To have better knowledge sharing in an organisation (I2) it is not reasonable trying to replace the OMT++ or XP method with the FAST method. Instead, it is important to understand the strengths and weaknesses of the method used and to find reasonable ways to compensate the weaknesses.

Conclusions

The knowledge sharing approach of software development methods is normally not very explicitly introduced. However, it is important from scientific and practical perspective to know it, because so many current problems in software development work are a result of difficulties in knowledge sharing. Here, the knowledge sharing approaches of three very different software development methods have been studied. These methods have been selected to represent three different approaches to software engineering: the traditional, the agile, and the product line based software development.

Knowledge sharing is an integral part of real life actions. It can't and shouldn't be fully separated from real life actions. That's why here the knowledge sharing has been studied through actions defined inside the methods. This study has resulted into a finding that the approach to knowledge sharing is very different between the selected three methods. This is visible especially in the KSF profiles.

Here, the purpose has not been to compare the overall goodness of these methods, except to highlight the knowledge sharing approach. These methods all have their place in different kinds of software engineering environments, and their applicability differ in different situations. Describing a software development method is always a result of contradicting aspects and needs. To assure simplicity of a method, it can't fully cover all possible aspects, e.g. the knowledge sharing aspect. However, through understanding the situation regarding to knowledge sharing, additional activities etc. could be initiated to improve the results and efficiency of software engineering work.

A limitation of this study is that the KSF profiles of the representative methods can't directly be generalized to represent the software engineering approach they represent. However, they give the basic understanding and the probable situation. The contribution of this study is the understanding of the differences of the methods from the knowledge sharing perspective. Through making the knowledge sharing more visible than it is today, it is possible to improve it.

The author's work has continued from this to find ways of improving existing software development processes in use with better knowledge sharing practices. A knowledge sharing pattern concept (Vesiluoma, 2006) has been proven to be an interesting, light-weight solution for this. E.g. some knowledge sharing practices found from these methods have been used when mining knowledge sharing patterns.

References

- Abrahamsson, P., Salo, O., Ronkainen, J. and Warsta, J. (2002). *Agile software development methods - Review and analysis*. VTT Publications 478, Espoo.

- Artto, K.A. (1998). A Management Framework for a Project Company. In proceedings of the 14th IPMA World Congress on Project Management, Ljubljana, Slovenia, 677-681.
- Aurum, A., Jeffery, R., Wohlin, C. and Handzic, M. (Eds.) (2003). *Managing Software Engineering Knowledge*. Springer-Verlag, Berlin, Heidelberg.
- Beck, K. (2000). *Extreme programming explained - Embrace change*. The XP Series, Addison-Wesley.
- Blackler, F. (1995). "Knowledge, Knowledge Work and Organizations: An Overview and Interpretation". *Organization Studies*, vol. 16, no. 6, 1021-1046.
- Boehm, B. (2006). "Value-Based Software Engineering: Overview and Agenda". In book Biffel, S., Aurum, A., Boehm, B., Erdogmus, H. and Grünbacher, P. (Eds.) *Value-Based Software Engineering*. Springer
- Boland, R.J. and Tenkasi, R.V. (1995). "Perspective Making and Perspective Taking in Communities of Knowing". *Organization Science*, vol. 6, no. 4, 350-372.
- Bosch, J. (2000). *Design and use of software architectures. Adopting and evolving a product-line approach*. Addison-Wesley.
- Clements, P. and Northrop, L. (2002). *Software Product Lines - Practices and Patterns*. The SEI Series in Software Engineering, Addison-Wesley.
- Gareis, R. (1996). The Application of the "New Management Paradigm" in the Project-Oriented Company. In Proceedings of IPMA '96 World Congress on Project Management, Paris, France, 687-689.
- Handzic, M. (2003). "Why is it Important to Manage Knowledge?" In book Aurum et al. (2003), 1-4.
- Hinds, P.J. and Pfeffer, J. (2003). "Why Organizations Don't "Know What They Know": Cognitive and Motivational Factors Affecting the Transfer of Expertise". In book: Ackerman, M., Pipek, V. and Wulf, V. (Eds.) *Sharing Expertise - Beyond Knowledge Management*. The MIT Press, Cambridge, Massachusetts, London, England.
- IEEE (2002). A special section on knowledge management in software engineering (several articles). *IEEE Software*, 19 (3), 14-15, 26-62.
- Jaaksi, A., Aalto, J-M., Aalto, A. And Vättö, K. (1999). *Tried & True Object Development. - Industry-Proven Approaches with UML*. Cambridge University Press.
- Järvinen, P. (2001). *On Research Methods*. Opinpajan kirja, Tampere, Finland.
- Kylmäkoski, R. (2006). *RaPiD7: A Collaborative Method for the Planning Activities in Software Engineering - Industrial Experiments*. PhD thesis. Tampere University of Technology, Publication 582, Tampere, Finland.
- Nonaka, I. (1994). "A Dynamic Theory of Organizational Knowledge Creation". *Organization Science*, vol. 5, no. 1, 14-37.
- Polanyi, M. (1966). *The Tacit Dimension*. Routledge & Kegan Paul, London.
- Royce, W.W. (1970). "Managing the Development of Large Software Systems". In proceedings of IEEE Wescon, 1-9.
- Rumbaugh, J., Blaha, M., Premerlani, W., Eddy, F. and Lorenzen, W. (1991). *Object-Oriented Modeling and Design*. Prentice Hall.
- Rus, I. and Lindvall, M. (2002). "Knowledge Management in Software Engineering". *IEEE Software*, vol. 19, no. 3, 26-38.
- Turner, K.L. and Makhija, M.V. (2006). "The Role of Organizational Controls in Managing Knowledge". *Academy of Management Review*, vol. 31, no. 1, 197-217.
- Weiss, D.M. and Lai, C.T.R. (1999). *Software Product-Line Engineering - A Family-Based Software Development Process*. Addison-Wesley.

- Vesiluoma, S. (2006). "Improving Knowledge Sharing in Software Engineering". *International Transactions on Systems Science and Applications*. Vol. 1, no. 2, 167-173.
- Vesiluoma, S. (2007). "Making Knowledge Sharing Visible in Software Engineering". In proceedings of *ECIS 2007*, 15th European Conference on Information Systems, St. Gallen, Switzerland.

Explaining Successful Integration of a Secure Information System Method into an Organization's ISD Process

Juhani Heikka

University of Oulu, Finland

juhani.heikka@oulu.fi

Abstract. Information security breaches cause huge financial losses to organizations. Therefore it is important to pay attention to Information Systems' (IS) security features through the development process. Despite this importance, prior research lacks a) empirical research on integrating Secure Information System (SIS) methods into organizations Information System Development (ISD) methods, b) analysis to explain successful integration of SIS methods in practice and c) the identification of those SIS method characteristics that have a positive influence on the integration. In this paper, we explain the successful integration of a SIS method in practice and provide a framework applying Diffusion of Innovation (DOI) and Protection Motivation Theories (PMT) to explain the successful outcome. The analysis results can be used as set of guidelines to improve SIS method integration in organizations. The study provides directions for future research.

Keywords. secure information systems, diffusion of innovations, protection motivation theory, action research.

Introduction

According to the latest information security studies, the majority (90 %) of organizations are exposed to security threats annually (Lawrence et al., 2006; 2007). A CSI/FBI survey reported that 56 % of responding organizations had experienced illegal abuse of their ISs during the past year. The financial losses caused by the abuse vary from couple of thousand pounds in small business to hundreds of thousands of pounds in large business corporations (DTI 2007). The OWASP's survey (2005) revealed that the majority of IS vulnerabilities are caused by errors in the designing and implementation of the ISs. These problems can be traced back to the problem of developmental duality which means that the IS and its security features are often designed and developed independently in two separate processes (Mouratidis et al., 2003; White and Dhillon 2001). This problematic situation leads to add-on security, where the IS security features are added into the system in the later phases of ISD, or in the worst case, are added into system when it is already in use, and when the security vulnerabilities are discovered (Baskerville 1992).

Earlier research has recognized that the developmental duality causes conflicts between functional and security requirements, may shorten the lifespan of the IS and make the ISD costs higher (Baskerville 1993; Soo Hoo 2004). The conflicts between functional and security requirements stem from the differing goals of the separate processes: functional developers want to provide as much functionality as possible, while security developers want to restrict risky functionality in the system. Usually, the two groups use different tools (methods, notations, etc.) because the existing ISD methods do not support the handling of security requirements (Baskerville 1992; McDermott and Fox 1999; Siponen 2005a). This might lead to a situation where there are communication gaps or “black holes” between different development phases. These gaps can cause problems such as loss of information (Figure 1.). The problem is highlighted in cases where the ISD phases are completed with different developers or teams.

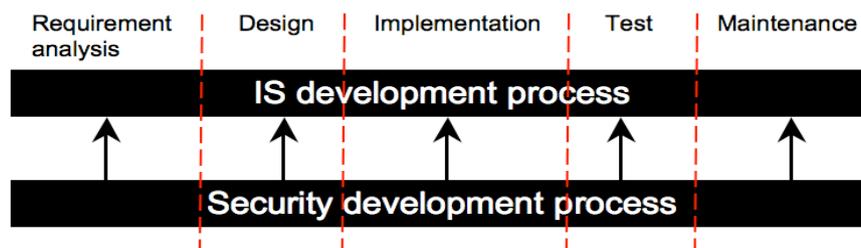


Figure 1. The developmental duality problem: IS and security development are two separate processes utilizing different methods and notations causing communication gaps between development phases.

The duality problem can be avoided by integrating a sufficient SIS method into the company’s ISD method (Baskerville 1992). To enable the handling of security requirements in ISD, many SIS methods have been introduced (see review articles by Baskerville 1993; Dhillon and Backhouse 2001; Siponen 2005a, 2005b; Villarroel et al., 2005). The methods include approaches from simple security checklists and standards (BS7799-1; ISO/IEC27001, Common Criteria, ISF), to logical approaches (Baskerville 1988) and security modified notations and modeling languages (Jürjens 2005; McDermott and Fox 1999; Sindre and Opdahl 2000). The latest SIS method trend includes more sophisticated, theoretically grounded approaches involving social aspects and techniques such as end-user participation (Hitchings 1996; James 1996; Siponen et al., 2006).

Although a diversity of SIS methods exists, they are not widely used in the industry. Those companies that apply SIS methods usually base their handling of security requirements on checklists or standards that do not solve duality or provide support for abstracting or modeling of organization specific security requirements. Therefore abstract models are needed as tools for designing and communication. By applying a SIS method that supports modeling, functional designers and security designers can form a shared specification including the all functional requirements and security features needed in securing the IS (White and Dhillon 2005).

To solve the duality, the selected SIS method must be integrated into organizations ISD process (Baskerville 1992; Siponen and Baskerville 2001). Integration involves the linking of the SIS method elements through the whole ISD process, starting from requirement analysis all the way to design, testing and maintenance. The research in this area has been concentrating on producing new SIS methods, whilst only little is known about the integration of SIS methods in practice, or which factors affect the integration. According to Baskerville (1994), Siponen (2006) and Dhillon and Backhouse (2001) IS security research has been concentrating on security standards, with the functional and technical aspects of IS security lacking empirical research. While only little empirical research exists in the area of SIS methods and their use in practical settings (Heikka and Siponen 2006; Mouratidis et al., 2003; Siponen et al., 2006), this research also lacks analysis of successful SIS method integration.

This paper illuminates the SIS method integration in the light of two theories: Diffusion of Innovation (Rogers 1995) and the Protection Motivation Theory (Rogers and Prentice-Dunn 1997). These theories are used to identify *which factors affect integration* and *what are the important SIS method characteristics?* The results provide interesting insights on SIS method integration and a novel model for interpreting the phenomena. In addition, the study provides practical implications, a set of guidelines that can be applied to facilitate the SIS method integration into ISD in the future. The field study was carried out in the form of action research in a large ISD company.

The paper is organized as follows. The second section introduces the selected SIS method. The third section includes the research methods and settings. The fourth section explains the integration of Meta-notation in the organization. The fifth section presents the research results analyzed in the light of selected theories. The sixth section includes discussion of the results. The final section presents the conclusions.

Meta-notation

Meta-notation is a SIS method developed by Siponen and Baskerville (2001) consisting of six security dimensions: *security subjects*, *security objects*, *security classification*, *security constraints*, *abuse subjects and scenarios* and *security policy*. The idea behind Meta-notation is to provide security dimensions that can be integrated into any ISD method or notation. The dimensions are high level abstractions of important security aspects to be considered during the ISD.

The security subjects are considered to be important actors in IS, for example end-users, employees, collaborators, network nodes, etc. Security objects are important assets in the system. Common examples of security critical assets in organizations are data, files, electronic and paper documents. The security subjects have a relevant relationship (access) to the security objects that can be restricted by using security classifications and security constraints. In the classification of subjects and objects, every user (security subject) and data object (security object) in the system is classified according their sensitivity by using the

selected classification system (for example: top secret, secret, confidential, unclassified). The security constraints are security requirements (confidentiality, availability, non-repudiation, etc.) derived from customer requirements and from organization specific security policy. Abuse subject and scenarios are exploited in security risk analysis and recognition of valuable assets in the system.

The security subjects and objects can be modeled with the selected notation, for example UML (Booch et al., 1999). Security subjects are usually modeled as stick figures, and their access to resources in the systems can be modeled with use cases. In modeling of security risks and unwanted actions (such as hacking or malicious code) in the system, abuse cases can be utilized (Figure 2).

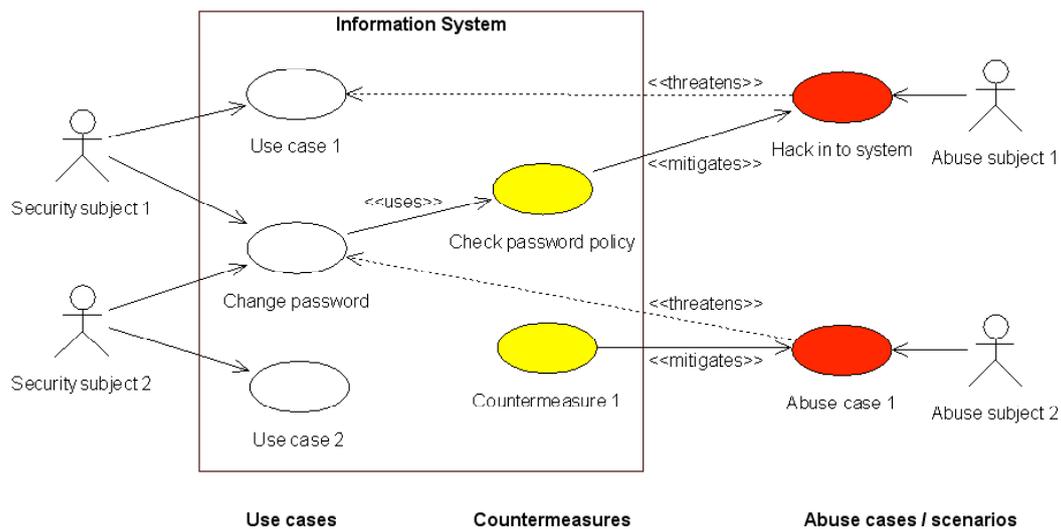


Figure 2. Illustration of security dimensions in a use case diagram.

The abuse cases are similar to normal use cases but they concentrate on security aspects and non-functional requirements (such as confidentiality, secrecy, etc.) by providing a set of security concepts to UML (McDermott and Fox 1999; Sindre and Opdahl 2000). The abuse cases are used in the analysis of security requirements, the design of security countermeasures and in the testing of IS security features (Figure 3).

<p>Abuse case: Name the abuse case, for example "Hacking into system".</p> <p>Priority: High / medium / Low.</p> <p>Frequency: Daily / Monthly, etc.</p> <p>Cost of recovering: Evaluate the costs if abuse is successful.</p> <p>Abuse subject: Identify the abuser, for example "Hacker".</p> <p>Preconditions: What are the preconditions for abuse to take place, for example "Hacker has the user ID and guesses the right password".</p> <p>Outcome: What is the outcome of the abuse? For example "Hacker is able to access the confidential data in the system".</p> <p>Description of countermeasure: How the system reacts and how the security object is secured from abuse?</p> <p>Extensions: Are there alternative abuse scenarios?</p> <p>Data: What security objects are abused or manipulated in this scenario?</p> <p>Requirements: What requirements are relevant to this abuse case?</p> <p>Test cases: How are the countermeasures tested?</p> <p>Version: In which version of the system is the countermeasure completed?</p> <p>Other issues: Other important issues?</p>
--

Figure 3. Example of an abuse case template including the needed security dimensions (Heikka & Siponen 2006).

The security constraints are used in cooperation with the security classification to restrict the access of security subjects to the security objects (Table 1). The security constraints can be also used to provide exceptions to access rules derived from security classifications based on specific needs. For example, in some cases a security subject classified into the confidential level may need access to secret information. In the technical implementation of constraints, different access control mechanisms can be applied (see Castano et al., 1995). The security policy is a potential source of security requirements, classifications and constraints, and it is used as a guideline to protect the system and its assets. Usually an organization's security policy defines the responsibilities, rules and practices for how sensitive information is protected and handled in the organization.

Table 1. Security subjects' access to security object (C=create, R=read, U=update and D=delete).

	Sec. object 1	Sec. object 2	Sec. object...	Needed operations
Sec. subject 1	R	CRD	U	CRUD
Sec. subject 2	R		U	RU
Sec. subject...	D	C	U	CUD

The six dimensions described above are used in different ISD phases. To make the utilization of the dimensions possible, they must be integrated into the ISD method used in the company.

Research methods and settings

Action research

Action research (AR) is a collaborative approach to investigation that provides people with the means to take systematic action to resolve specific problems in an organization (Stringer 1999, p.17). In the IS field, it has been advocated as the ideal for studying ISD methods in their practical settings (Avison et al., 2001; Baskerville 1999). By putting theories to work in practice, scientific knowledge is expanded and concrete problems are solved in the participating organizations (Baskerville and Wood-Harper 1996; Järvinen 2007). In this way AR aims at two goals simultaneously, and AR studies have been recently called for by IS security scholars (Baskerville 1994; Baskerville and Myers 2004; Dhillon and Backhouse 2001).

AR is a form of field intervention consisting of five phases: 1) *diagnosis*, 2) *action planning*, 3) *action taking*, 4) *evaluation* and 5) *specifying learning*. The diagnosis aims at identifying or defining the problem area. In the action planning, the different alternatives for problem solving are considered. In the action taking, the planned actions are carried out in the organization. After field intervention, the results are evaluated to find out if the problems were solved. Specifying learning includes the identification of the general findings of the study. AR is a cyclical process where these phases are repeated until the diagnosed problems in the organization are solved. (Baskerville 1999).

In this research, the data was collected through interviews, meetings, email discussions, problem lists and observations (Table 2.). In addition, the researcher used a research diary to collect interesting notes during the study. The interviewed specialists represent various knowledge areas from the company including the head of the ISD department, the chief designer, SW architects, method specialists, the project manager and the technical specialist.

Table 2. Data collection during the research.

Data collection	Description	Participants
Email discussions	Received answers: 102	10 persons
Meetings	10, duration 20 hours	10 persons
Interviews	11, duration 15 hours	8 persons
Problem lists	3, including 87 comments	3 persons
Observation	40 hours	3 persons

Research settings

At the beginning of 2004, we contacted a company which had earlier expressed their interest in improving their ISD method to handle its security requirements more effectively. We arranged a meeting with the chief designer and the head of

the ISD department to discuss the possibility of a research project. In the meeting, we discussed the needs recognized by the company, and the theoretical solutions that could be applied in the situation. The company's chief designer had earlier studied SIS methods, and he agreed that the Meta-notation proposed by the researchers seemed to be a promising approach. The company expressed their interest in researching the integration of Meta-notation into their ISD method. The goal was set of avoiding duality by integrating the security dimensions into all phases of ISD, starting from the requirements analysis all the way to the maintenance.

After the integration, the Meta-notation was evaluated in a development project of a security critical web application. The security was considered to be important because the company sells SW update packages to clients through its system that is connected to the Internet. The company wanted to ensure that sharing these updates was safe. The security issues were considered from two viewpoints. Firstly, the company did not want to take a risk that someone could download the SW updated packages for free. Secondly, the company has a responsibility to check that the update packages are compatible and working with clients systems. This means that it is crucial that every package goes through careful inspection before publication. In the worst case, the client companies could demand refunds for non-working packages or non-functioning systems.

The development project started in December 2004, and lasted three months. The project was carried out by three experienced IS specialists in the company: a project manager, a technical specialist and an SW architect. During the development, the team utilized five security dimensions. They decided not to use security classifications because they felt that access control was easier to implement by using security constraints.

Integration of Meta-notation into the Company's ISD

The research process started with an analysis of existing SIS methods. The analysis was guided by prior studies that had reviewed the existing SIS methods, recognizing their strengths and weaknesses (Baskerville 1993; Dhillon and Backhouse 2001). Siponen and Baskerville (2001) concluded that the majority of SIS methods are difficult to integrate into ISD methods. The reason is that the SIS methods force IS developers to apply the processes and notations provided by the method. In many cases, the processes and notations are not compatible with ISD methods used in the organization. When this happens, the selected SIS method is not able to solve the duality. Based on the earlier studies and our analysis, Meta-notation seemed to be an approach that could be implemented.

The field study in the company started in the spring of year 2004 (Figure 4). First, the researcher became acquainted with the company's ISD method and processes. In small ISD projects, the company utilizes a process based on Rapid Application Development (RAD) while large-scale ISD projects are completed by using the waterfall approach. The company decided that Meta-notation should be integrated into RAD. The ISD processes of the company use the same tools

(document templates, instructions and notations) in development, so integrating the Meta-notation security dimensions into the RAD process would result in tools that could be used in other processes.

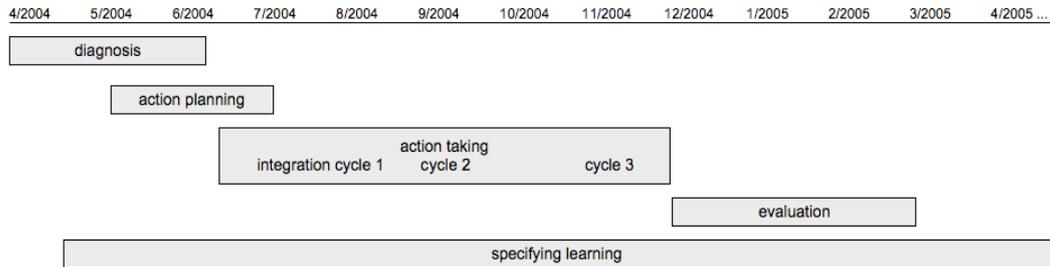


Figure 4. The AR phases in the organization.

Diagnosis

In the beginning of the integration process, we interviewed four IS practitioners in the company. The interviews aimed at identifying targets for development in the company. In the interviews, the practitioners reported the lack of a systematic SIS method. According to the head ISD department: *“our operations model [the ISD method of the company] does not include instructions for designing or implementing information security”*. According to the ISD method specialist *“the [security] methods in use are too narrow and old, but not totally imperfect”*. The company’s SW architect commented that their ISD method *“is not systematic enough [in handling of security requirements]”*. From the interviews, we could recognize a set of requirements for SIS method integration: 1) the security dimensions should cover all ISD phases to bridge the communication gaps and to avoid misunderstanding and loss of information - this was especially important because the ISD phases are carried out by different IS developers or teams in the company; 2) the support for top management in informing and demonstrating the security risks of the IS; and 3) the need for updating of security related ISD instructions.

Action Planning

The action planning was guided by the analysis of the SIS methods, and the findings reached in the diagnosis. From the existing SIS methods, the Meta-notation was selected to be integrated into the company’s ISD. The goal was to overcome the developmental duality and the problems recognized in the organization. Because there were no comprehensive empirical examples of integration of the Meta-notation available, we decided to start with example documents that were to be commented by the practitioners of the company.

The Meta-notation integration started from the requirement analysis phase. We formed four documents to demonstrate the security dimensions in the company’s ISD. The results were discussed in a meeting with the chief designer, the head of

the ISD department and the SW architect of the company. The participants commented that the approach presented was promising, and decided that integration would be done in similar way with other ISD documents.

Action Taking

In the action taking, the we continued the integration which was completed after three integration cycles. The integration affected 25 out of 44 process documents, and resulted three new documents on abuse subjects and scenarios, process description and ISD security instructions. The integration phase took altogether eight months. The feedback and research data was collected with interviews, meetings, email discussions, problem lists and observations.

During the integration, the locations of the security dimensions were changed from one document to other to make the more process systematic. In the interview the company's SW architect pointed out that: "*the data should not be repeated twice in the documentation*". By making the important note, the process could be intensified and possible places for misunderstandings could be removed. This way the adoption of the Meta-notation could be made easier for the IS developers.

Evaluation

Evaluation of the Meta-notation was carried out in a development project on a web application. After the project, the researcher participated in the evaluation of the project documentation in collaboration with the specialists. The team presented the results in a four-hour meeting where we discussed the outcome and usefulness of the approach. The researcher interviewed the specialists after the meeting in order to validate the success of the integration and to form a richer picture about the experiences in the use of Meta-notation in a practical setting.

The Analysis of the Action Research Results

Purpose of the analysis is to recognize factors that have an effect on the successful integration of SIS methods in practice. By identifying these factors, we can be improve our understanding of the phenomena, in other words understand how the integration should be carried out and what are the possible barriers for integration. Because there are no IS specific theories to explain the phenomena, we had to form the framework by utilizing theories from other disciplines. The DOI theory provides a useful framework for analysis. In the analysis of the phenomena, however, we found components that required the combining of different theories. PMT provides interesting perspectives for interpretation of organizational motivation and external pressure in the context of SIS methods. The analysis is summarized in the Figure 5.

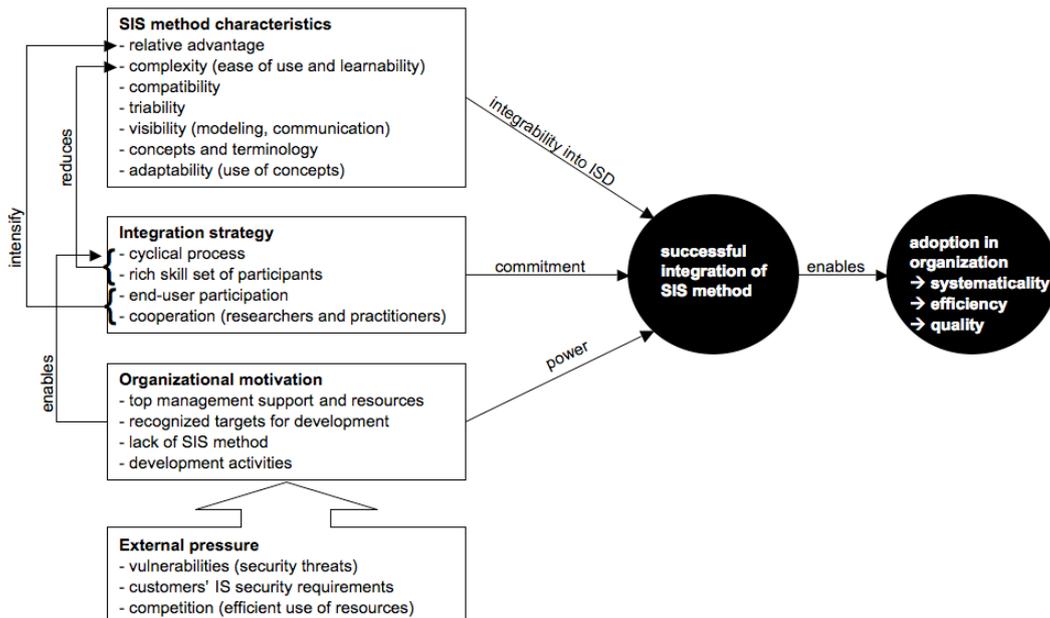


Figure 5. Result of analysis explaining relationships of elements affecting successful integration of SIS methods.

The Stages of Adoption

The DOI theory provides interesting perspectives for analyzing the results of the AR. The theory is usually used to explain how a new artefact or technique migrates from creation to use in a certain context. The theory identifies five stages of adoption and five important characteristics of the artefact.

The first stage of adoption is *knowledge* where the artefact is exposed to existence (Rogers 1995, p.162). In this case, based on the analysis, the researcher selected the suitable SIS method (Meta-notation) and introduced it in the organization. The second phase, *persuasion*, was to form a favourable attitude towards the artefact (Rogers 1995, p.167). In the action planning phase, the specialists of the company gave positive feedback on the four example documents and felt that Meta-notation was a worthwhile approach that could be implemented. According to the head designer “*the approach [Meta-notation] looks good and is suitable for our purposes*”.

The *decisions* phase involves the commitment to adopt the artefact (Rogers 1995, p.171). Based on the judgment of the company’s specialists the integration was carried according to the way outlined in the example documents and the integration was completed after three AR cycles. During the integration, the company’s SW architect pointed out in an interview that “*the role of information security in ISD should not be over emphasized*”. By this he meant that security should be in line with other important quality aspects (usability, performance, flexibility, etc.) in the company’s ISD documentation. The SW architect

continued: “*Academic terminology should be removed and replaced with terms used in the company. For example, the security subjects are the same as user roles – they should be represented in similar way ... The conceits should be expressed using the same terms as in the company*”. By making these important notes, the terminology was standardized, and the role of the security dimensions was balanced with a view to improving the adoption of the Meta-notation. After these fine-adjustments the developers were committed to use the Meta-notation in an ISD project.

The *implementation* phase involves the artefact being put in to use (Rogers 1995, p.172). In this AR process, the Meta-notation was used in a development project of a web application. The *confirmation* phase reinforces the positive outcomes from the use of the artefact (Rogers 1995, p.180). In the interviews, the specialists reported that they could document the security requirements in a more rigorous and systematic way. The project manager commented: “*The biggest advantage from using the method is that security requirements will be documented*”. The SW architect reported: “*The method did help us to pass requirements and specifications from one ISD phase to the next*”. This way they were able to avoid possible communication gaps between developers and ISD phases. Especially the specialists found the abuse subjects and scenarios useful. According to the technical specialist “*the approach helps in risks analysis as well as in prioritization of security requirements and countermeasures*”. The specialists reported that they are likely to use the method in the future, also in situations other than security critical ISD.

The Important Characteristics of SIS Methods

The DOI theory identifies five important characteristics that a successful innovation should include. *Relative advantage* describes the extent to which the artefact is separated from its competitors (Rogers 1995, p.212). In the interviews, the IS specialists expressed that use of the Meta-notation did help them to document the security requirements systematically. In addition, they saw that the new approach not only helped in risk analysis and modeling of security requirements but also in blurry or controversial situations. According to the technical specialist “*the abuse cases [and scenarios] are useful in situations where it is unclear between the company and the client if the unwanted feature is a bug or undefined feature*”. Earlier the company had had problems in such situations.

Based on the analysis of SIS methods (Baskerville 1993; Siponen 2005a, 2005b) and the empirical evidence collected during this AR, it is clear that Meta-notation can solve the developmental duality problem. From the viewpoint of solving duality, the Meta-notation also has advantages compared to other SIS methods that cannot be integrated into ISD methods, as well as the old ISD method used in the company.

Compatibility refers to the consistency between the new artefact and the existing values, experiences and needs (Rogers 1995, p.224). In our diagnosis, we identified a set of needs (the lack of SIS method, unsystematic handling of

security requirements and outdated security instructions) existing in the organization. The Meta-notation was originally designed so that it could be integrated into any ISD method or notation (Siponen and Baskerville 2001). The integratability is based on the idea of the high-level Meta-method that describes how ISD methods can be enriched with security dimensions to achieve a comprehensive secure ISD method. The most important point of view behind the idea is to modify the ISD method and the processes used in the organization as little as possible, but at the same time provide the crucial elements (security dimensions) to be used in the handling of security requirements during ISD. This way integration is made possible without obliging the users to change their usual CASE tools, notations or processes.

In the evaluation, the IS specialists of the company noted that they did not have to change their way of working and they could optimize the method according to the security criticality of the project. The project manager put it: *“there is no big difference [in making specifications with Meta-notation]... especially the abuse cases fit well into the model [the ISD method of the company]”*. The SW architect pointed out that *“not all of the security dimensions provided by the Meta-notation are necessary in every project”*. According to Siponen and Baskerville (2001), the Meta-notation can be optimized according to the needs of an ISD project like that carried out by the IS specialists in the evaluation by deciding not to use security classifications. Yet the SW architect felt that *“it is positive that all six dimensions were integrated and they could be used when necessary”*. In using familiar case tools the IS developers could produce security specifications and demonstrate the results to other interest groups (IS specialists, customers, top management, researchers, etc.).

Complexity describes the difficulty in understanding the use of the artefact (Rogers 1995, p.242). In the interviews, the IS specialists reported that Meta-notation was quite easy to use and could be utilized in a similar way to their earlier ISD method. According to the technical specialist *“It is always challenging to apply new methods for the first time, but I do believe that applying this method [Meta-notation] is no more difficult than others... However, the use does require basic skills in information security”*. The SW architect felt that *“security classifications were hard to understand at first and I would use them only when needed”*. According to the three IS specialists the abuse subjects, scenarios and cases were easy to use because they were already familiar with the concepts of use cases and UML.

During the research, the complexity was reduced with the help of end-user reviews after every integration cycle. The cooperative and cyclical nature of the AR enabled revisions of the security enriched ISD method, and in this way the cause of the complexity could be identified and removed. For example, the terminology could be standardized and the repetitive information in different specifications could be removed. The latter point is important in avoiding differing information in specifications. This also helps in avoiding misunderstandings and intensifies the ISD.

Triability is the degree to which an artefact may be experimented with on a limited basis (Rogers 1995, p.243). In this case, the Meta-notation was tried in a

real-life project where the IS specialists evaluated the approach. The approach was easy to try because it was integrated into the company's own ISD method. Further, the security dimensions can be utilized depending on the project requirements and the developers' experiences. For example, if the developers feel after the trial that some dimensions are not needed in every project, they can use only those dimensions they identify as being important (Siponen and Baskerville 2001).

Observability expresses the visibility of the results caused by the use of the artefact (Rogers 1995, p.244). By applying the Meta-notation, the IS specialists could improve the visibility of the security features of the IS under construction. According to technical specialist: "*Meta-notation helps us [the developers] to communicate more effectively with other interest groups*". In this way the misunderstandings and the developmental duality can be avoided. By applying the new approach, the visibility of security related issues to the customer can be improved, which in an ideal case can be an advantage to the company. The use of the approach can improve the organizations' image and customer confidence that security issues are paid attention to during the development, and the solutions are documented in a rigorous manner. This also helps the customer audits and maintenance of IS in the future.

During the research, we established that it is important to find a perfect balance between the visibility of the SIS method and the security dimensions compared to other quality issues like performance or usability. The visibility of security features in ISD should not be over-emphasized because it can lead to user resistance or competition between other quality attributes. For example, the IS specialists who are interested in usability might think that the new approach belittles the role of usability by overemphasizing the security issues that are often seen as obstacles to usability.

Organizational Motivation

The organizational motivation for adopting the new SIS method in the company required a wider perspective than simply the relative advantages of Meta-notation. An interesting approach to interpreting organizational motivation is PMT (Rogers and Prentice-Dunn 1997). The PMT is best known for its use in health science, and traditionally it has been used to motivate people to avoid unhealthy behaviour, for example smoking or alcohol abuse. In this case, security threats can be seen as unhealthy for the company and its clients, thereby requiring motivation for designing secure ISs and paying attention to security requirements through utilizing a SIS method. Also external pressure (security threats, security requirements, etc.) had a positive impact on the company's motivation to adapt Meta-notation.

The PMT consists of two main components: *threat appraisal* and *coping appraisal*. The threat appraisal is divided into two elements: vulnerability and rewards. In this case, the company's specialists had recognized that security threats (vulnerabilities) have become more common (severity) and there was a clear need for a SIS method. According to the head of the IS department, their

ISD tools must be updated to respond to today's security threats: "*information security is an issue that changes over time with technical development ... The instructions and operations model must be updated and considered regularly.*" The risk or fear of vulnerabilities in their products is higher if they do not have adequate tools for designing security features. By avoiding duality, the use of resources and quality of products was improved. Extrinsic rewards, such as status, peer approval or security, improves motivation for adapting new behavior, in this case use of Meta-notation. After this project, the participants do have the best knowledge about use of Meta-notation in the organization. The knowledge can be utilized in forthcoming projects.

Coping appraisal includes *efficacy* and *cost* elements. In this case, the response costs were relatively low. The SIS method was integrated in collaboration with the researcher and no new CASE or ISD tools were needed. Of course, in a larger scale adoption of Meta-notation, training in the company is needed. The collaboration and end-user involvement created important knowledge that could be utilized in such training. By utilizing Meta-notation, the developers are more capable (*efficacy*) of avoiding vulnerabilities in ISs.

Integration Strategy

In this research project, we chose AR as the research method and as an integration strategy. The cyclical nature of AR was practical and helped us to remove the complexity of the new approach in cooperation with the company's IS specialists (Figure 5.). The cooperation and end-user involvement enabled the optimization of the approach, and they brought practical know-how on use of the tools into the integration process. In many cases, the practitioners do not use ISD in same way that it is presented in the documentation, so it is important to understand how the ISD method is actually used. This way company's specialists were able to modify the approach to be more usable by giving feedback on different issues, like the terminology, during the research.

The rich skill set of the specialists provided important know-how from different fields (management, methods, ISD, etc.) and provided valuable information and feedback about the integration. The different viewpoints provided a wide set of issues to be considered during the integration. This was one of the key issues in the successful integration of Meta-notation. A participative decision making process also improves commitment (Quinn et al., 1996) and creates new knowledge in the organization.

The management (the head of the ISD department and the chief designer) provided the needed resources and support for the integration and optimization of the approach. The management understood the importance of security, and their support and motivation had a crucial role in completing the project.

Discussion

Baskerville and Wood-Harper (1998) have proposed seven validity criteria for IS action research that were fulfilled in this study: 1) the research was set in a multivariate social situation, 2) the observations were recorded and analyzed in an interpretive frame, 3) researcher actions intervened in the research setting, 4) the data collection methods included participatory observation, 5) changes in the social setting were studied, 6) the immediate problem in the organization was solved during the research and 7) we illuminated a theoretical framework that explained how the actions led to the favourable outcome.

This study has provided interesting findings on Meta-notation integration in practice. In the analysis, we formed a novel model explaining factors influencing integration. The study recognized important factors, through DOI and PMT, that have a positive effect on SIS method integration in the organizations. The most important factors include the *SIS method characteristics*, *integration strategy*, *organizational motivation* and *external pressure*.

DOI is traditionally used to explain the immigration of innovation in a certain context. In this study, we used the theory as a lens for an analysis explaining the successful integration of the SIS method to identify the important factors affecting the integration. Earlier, DOI has been utilized to explain acceptance of ISD methods (Riemenschneider et al., 2002) and adoption of ISD process innovations (Mustonen-Ollila and Lyytinen 2003). Other relevant theories that could have been utilized in the analysis include the Technology Acceptance Model (Davis 1989) but DOI provided a richer set of concepts that explain the phenomena.

PMT provided an interesting viewpoint for interpreting the organizational motivation and external pressure. The theory is traditionally applied in health science but it provided a fresh viewing angle in the context of SIS method integration. Earlier PMT has been successfully utilized in the context of information security by Pahlila et al. (2006).

The study has some limitations. DOI was applied to explain successful integration of a SIS method into the company's ISD processes, not to explain the immigration of the SIS method in the organization. The actual wide-scale adoption in the organization was not studied during this research, but we did receive preliminary information about the improvement of systematicity and efficiency. The IS specialists who participated in the study can be seen as future change agents who will have a major impact on the use of Meta-notation in the organization.

Implications for research include the model recognizing important factors influencing integration based on the two theories. The results can also be utilized in future SIS method development to produce integrateable and usable SIS methods. The study also provides important practical insights for integrating and adopting SIS methods in organizations. The findings can help future integration of SIS methods by providing a set of factors that should be considered in the integration. The study also shows that Meta-notation is a useful method in the handling of security requirements in ISD.

Conclusions

In this paper we provided a framework for interpreting the successful integration of a SIS method in a practical setting. The study shows, that AR is an ideal integration strategy for SIS methods. Its cyclical nature provided successful outcomes in solving the duality problem in the company and revealed interesting data about the phenomena. The implications for practice include a set of characteristics that SIS methods must fulfil to be able to be integrated into ISD methods used in companies. The model presented can be also used in future research efforts to develop new SIS integrateable SIS methods. In the future, it is important to study the wider adoption of the method and the practicality of the presented framework.

References

- Avison, D., Baskerville, R. & Myers, M. (2001). "Controlling Action Research Projects," *Information Technology and People*, Vol. 14, No.1, 28–45.
- Baskerville, R. *Designing Information Systems Security*, John Wiley Information Systems Series, 1988.
- Baskerville, R. "The Developmental Duality of Information Systems Security," *Journal of Management Systems*, Vol. 4, No. 1, 1992, pp. 1–12.
- Baskerville, R. "Information Systems Security Design Methods: Implications for Information Systems Development," *ACM Computing Surveys*, Vol. 25, No. 4, 1993, pp. 375–414.
- Baskerville, R. "Research Notes: Research Directions in Information Systems Security," *International Journal of Information Management*, Vol. 14, No. 5, 1994, pp. 385–387.
- Baskerville, R. and Wood-Harper, T. "A Critical Perspective on Action Research as a Method for Information Systems Research," *Journal of Information Technology*, Vol. 11, 1996, pp. 235–246.
- Baskerville, R. and Wood-Harper, T. "Diversity in Information Systems Action Research Methods," *European Journal of Information Systems* Vol. 7, 1998, pp. 90–107.
- Booch, G., Jacobson, I., and Rumbaugh, J. *The Unified Modeling Language User Guide*. Addison Wesley, 1999.
- BS7799-1, "Code of Practice for Information Security Management," *Department of Trade and Industry*, 2000.
- Castana, S., Fugini, M., Martella, G. and Samarati, P. *Database Security*. ACM Press, New York, 1995.
- Common Criteria, "The official version of the Common Criteria and of the Common Evaluation Methodology is v2.3," 2006.
- Department of Trade and Industry (DTI). "Information Security Breach Survey 2006," *Department of Trade and Industry Publications*, UK, 2007.
- Davis, F. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* Vol. 13, No. 3, 1989, pp. 318–339.
- Dhillon, G., and Backhouse, J. "Current directions in IS security research: toward socio-organizational perspectives," *Information Systems Journal* Vol. 11, No. 2, 2001 pp. 127–153.

- Heikka, J., and Siponen, M. "Abuse Cases Revised: An Action Research Experience," *Proceedings of Pacific Asia Conference on Information Systems*, 2006, pp. 673–684.
- Hitchings, J. "A Practical Solution to the Complex Human Issues of Information Security Design," in Katsikas S.K., and Gritzalis, D. (eds.) *Information Systems Security: Facing the Information Society of 21st Century*, Chapman & Hall, 1996, pp. 3–12.
- International Security Forum (ISF), "The Forum's Standard of Good Practice for IS Security," 2005, available at http://www.isfsecuritystandard.com/index_ie.htm
- International Organization for Standardization, "ISO/IEC27001 - Information technology – Security Techniques – Information Security Management Systems – Requirements," *International Organization for Standardization*, 2005.
- James, H. "Managing Information Systems Security: A Soft Approach", *Proceedings of the Information Systems Conference of New Zealand*, 1996.
- Jürjens, J. *Secure Systems Development with UML*. Springer-Verlag, 2005.
- Järvinen, P. "Action Research is Similar to Design Science," *Quality & Quantity*, Vol 41, 2007, pp. 37–54.
- Lawrence, G.A., Loeb, M.P., Lucyshyn, W., and Richardson, R. "2006 CSI/FBI Computer Crime And Security Survey," *Computer Security Institute Publications*, 2007.
- Lawrence, G.A., Loeb, M.P., Lucyshyn, W., and Richardson, R. "2005 CSI/FBI Computer Crime And Security Survey," *Computer Security Institute publications*, 2006.
- McDermott, J., and Fox, C. "Using Abuse Case Models for Security Requirements Analysis," *Proceedings of the 15th Annual Computer Security Applications Conference*, 1999, pp. 55–64.
- Mouratidis, H., Giorgini, P., and Manson, G. "Integrating Security and Systems Engineering: Towards the Modeling of Security Information Systems," *Proceedings of Conference on Advanced Information Systems Engineering*, 2003, pp. 63–78.
- Mustonen-Ollila, E., and Lyytinen, K. "Why Organizations Adapt Information System Process Innovations: A Longitudinal Study Using Diffusion of Innovation Theory," *Information Systems Journal* Vol. 13, 2003, pp. 275–297.
- Open Web Application Security Project (OWASP). "Top Ten Most Critical Web Application Security Vulnerabilities," 2006, <http://www.owasp.org/documentation/topten.html> (referenced 7.3.2007).
- Quinn, R.E., Faerman, S.R., Thompson, T.P and McGrath, M. *Becoming a Master Manager - A Competency Framework*. John Wiley & Sons, 1990.
- Pahnila, S., Siponen, M. and Mahmood, A. "Employees' Behavior towards IS Security Policy Compliance," *Proceedings of the 38th Hawaii International Conference on System Sciences*, 2007, pp. 156–166.
- Riemenschneider, C.K., Hardgrave, B.C., and Davis, F.D. "Explaining Software Developer Acceptance of Methodologies: A Comparison of Five Theoretical Models," *IEEE Transactions on Software Engineering* Vol. 28, No. 12, 2002, pp. 1135–1145.
- Rogers, E.M. *Diffusion of Innovations* (4th edition), The Free Press, New York, 1995.
- Rogers, R.W., and Prentice-Dunn, S. "Protection motivation theory," In D. Gochman (Ed.), *Handbook of Health Behavior Research (1): Determinants of Health Behavior: Personal and Social*. Plenum, NY, 1997, pp. 113–132.
- Sindre, G. and Opdahl, A.L. "Eliciting Security Requirements by Misuse Cases," *Proceedings of 37th International Conference Technology of Object-Oriented Languages and Systems*, 2000, pp. 120–131.

- Siponen, M. "Analysis of modern IS security development approaches: towards the next generation of social and adaptable ISS methods," *Information & Organization*, Vol. 15, No. 4, 2005a, pp. 339–375.
- Siponen, M. "An Analysis of the Traditional IS Security Approaches: Implications for Research and Practice," *European Journal of Information Systems*, Vol. 14, 2005b, pp. 303–315.
- Siponen, M. "Information Security Standards Focus on the Existence of Process, Not Its Content," *Communications of the ACM*, Vol.49, No. 8, 2006, pp. 97–100.
- Siponen, M. and Baskerville, R. "A New Paradigm for Adding Security Into IS Development Methods," *Proceedings of Conference on Information Security Management and Small Systems Security*, 2001, pp. 99–112.
- Siponen, M., Baskerville, R., and Heikka, J. "A Design Theory for Secure Information Systems Design Methods," *Journal of the Association for Information Systems*, Vol. 7 No. 11, 2006, pp. 725–770.
- Soo Hoo, K., Sudbury, A.W., and Jaquith, A.R. "Tangible ROI through Secure Software Engineering," *Secure Business Quarterly*, Vol. 1: No. 2, 2001, pp. 1–4.
- Stringer, E.T. *Action Research* (2nd edition). Sage Publications, 1999.
- Villarroel, R, Fernández-Medina, E and Piattini, M. "Secure Information Systems Development – A Survey and Comparison," *Computers and Security*, Vol. 24, No. 4, 2005, pp. 308–321.
- White, E.F.R., and Dhillon, G. "Synthesizing Information System Design Ideals to Overcome Developmental Duality in Securing Information Systems," *Proceedings of the 38th Hawaii International Conference on System Sciences*, 2005, pp. 186–195.

Assessment Tools as Drivers for SPI: Short-term Benefits and Long-term Challenges

Sune Dueholm Müller
University of Aarhus,
Aarhus School of Business
Denmark
sdm@asb.dk

Jacob Nørbjerg
Copenhagen
Business School
Denmark
jan.inf@cbs.dk

Hiu Ngan Cho
Financial Services Sector
IBM
Denmark
hiucho@dk.ibm.com

Abstract. Full scale software process maturity assessments are costly, can have large organizational impact, and are carried out at long (12-24 months) intervals. Consequently, there is a need for techniques and tools to monitor and help manage an SPI project through inexpensive, ongoing progress assessment. In this paper we present findings from two cases of using such a tool. We have found that the tool does provide useful snapshots of the status of an SPI project, but that long-term use of the tool introduces costs and challenges related to modifying and tailoring the tool to both the organizational context and the SPI implementation approach. Also, persistent use of an assessment tool may jeopardize assessment reliability due to wear-out and routinization.

Keywords. Software process improvement, software process assessments, assessment tools, appraisal.

1. Introduction

Software process assessments play an important role in Software Process Improvement (SPI). An assessment provides insight into the current state of the organization's software processes and helps prioritize improvement initiatives. Assessments are also used to periodically evaluate and re-plan ongoing SPI initiatives (CMMI Product Team, 2002; Humphrey, 1990; McFeeley, 1996). The dominating approaches to SPI evaluate software processes against a normative

model of 'best practice', i.e. software capability maturity models such as CMMI-SE/SW (CMMI Product Team, 2002), Bootstrap (Haase et al., 1994), and most recently CMMI for Development (CMMI Product Team, 2006).

Norm-based assessments are, however, very costly and they have a high impact on the organization. They are, therefore, relatively rare events that are used to initialize an SPI initiative and for periodic assessments of progress and results. Thus, 12-24 months is a typical interval between assessments (SEI, 2005). Assessments are, furthermore, primarily used to identify software process problems and set goals for improvement initiatives at the organizational level, but are not suitable for evaluating local (project level) software processes and software process improvements (Daskalantonakis, 1994).

There is, therefore, a need for techniques and tools to monitor SPI projects and help software practitioners whose practices must change assess their own practices and document improvements between regular full scale assessments (Arent et al., 2000; Daskalantonakis, 1994). To fulfill these objectives, the tools and techniques should be relatively easy to use, require little outside help or support, and have low cost of use (time spent on an assessment). The tools and techniques should, furthermore, be consistent with the framework used in full-blown appraisals in order to be able to document improvements in terms of the overall organizational SPI project.

Experience from having used such tools and techniques in ongoing SPI initiatives show that they can be useful drivers in SPI projects. Regular assessments at the local level is a low cost, low impact activity that helps disseminate knowledge about good software practices, provide a vehicle for reflection about own practices, and create commitment to the implementation of new and improved practices (Arent et al., 2000; Daskalantonakis, 1994).

These results are encouraging, but there is a need for more research into the long-term role and effect of assessment tools in SPI. In this paper we therefore set out to explore the use of tool based assessments to drive and support SPI projects over long periods of time. The research is based on the use of a web-based assessment tool to support SPI projects in two different organizations. The tool is compliant with level 2 of the (staged) version of the CMMI-SE/SW (CMMI Product Team, 2002).ⁱ

In one of the organizations the use of the tool was studied over a period of 2 years and in the other over 6 months. The study shows that (a) the tool can be a useful driver for SPI projects but not without proper management support and pressure; (b) although the tool allows for quick and low cost maturity assessments in projects, the long-term costs of maintaining and using the tool are non-trivial; (c) long-term use of the tool involves a risk of routinization, i.e. the practitioners using the tool do not critically examine their practices when answering the questions on the questionnaire that is part of the tool, but 'turn on the auto pilot'.

In the next section we briefly introduce software process maturity and assessment methods, and discuss previous research about tool support for software process assessments. Section 3 describes the tool, and section 4 outlines the research method. The two cases in which the tool has been used are presented in section 5, and the results are summarized and discussed in section 6. Section 7 concludes the paper.

2. Software capability models and assessments

The dominating approaches to SPI are based on a norm or model that specifies 'good' or mature software processes against which an organization can compare its own practices. Well known models include CMMI (CMMI Product Team, 2002) and Bootstrap (Haase et al., 1994). The models describe increasing levels of maturity from the lowest level characterized by frequent budget and time overruns, quality problems, low efficiency, and few (if any) documented processes to the highest level at which processes are well defined (and followed), there is careful and detailed monitoring of projects, and ongoing planned and controlled fine tuning of processes. The assumption is that as an organization increases its maturity level, it will also improve its performance, i.e. the accuracy of estimates, the quality of products, and the efficiency of its processes.

The maturity models have been criticized for being too large and complex for small to medium sized companies to use and for their lack of support for tailoring to different business and application domains (Aaen, 2002; Aaen et al., 2004; Bach, 1995; Bollinger et al., 1991). Critics have also argued that the maturity models may lead organizations to focus on the requirements of the model instead of the problems the organization actually faces (Iversen et al., 1999). The maturity models have, nevertheless, gained wide recognition in spite of criticism, thus underlining the need for research into their application and use.

Assessments provide a basis for benchmarking and comparing organizations which is useful when, for example, selecting a software supplier. Thus, a dominant player like the U.S. Department of Defense requires potential software suppliers, i.e. sub-contractors, to be certified at CMMI level 3 (Hansen, 2005). Additionally, the models give firms undertaking SPI a tested and well known framework for assessing their processes and prioritizing improvement initiatives.

The models are very complex, however, and describe each maturity level in great detail. The specification of the CMMI-SE/SW, for example, comprises 573 pages (CMMI Product Team, 2002). Consequently, a full scale appraisal against a maturity model is a time-consuming and costly affair that involves a team of trained assessors and may take as long as 1-2 weeks. Therefore, companies undertaking model based SPI typically repeat such appraisals only at 12-24 month intervals (SEI, 2005).

2.1 Assessment methods and tools

Based on a quick literature survey, we divide methods, tools, and techniques for software process assessments into three main groups. First, there are the assessment methods, questionnaires and other tools, and assessor training programs that accompany the major maturity models (see e.g. Dunaway et al., 2001). Some research has produced additional computer based tools for results visualization (e.g. Hunter et al., 1997) and support for prioritization of improvement initiatives (Gorschek et al., 2004).

A second group of research addresses assessment techniques and tools with lower organizational impact and cost, often adapted to smaller organizations. The RAPID assessment method based on the SPICE model (ISO/IEC JTC1/SC7/WG10, 1998) uses one-day assessments and has been used successfully in small-to-medium sized organizations (Cater-Steel et al., 2006). Also based on the SPICE framework, the SPINI and MARES assessment methods facilitate adaptation of an assessment to the needs and resources of small enterprises (Gresse von Wangenheim et al., 2006). Iversen et al. describe the use of a questionnaire based survey to assess an organization according to level 2 of the original SW-CMM (Iversen et al., 1998), and Kautz et al. use an approach inspired by GQM to select a few improvement areas in very small organizations (Kautz, 1998; Kautz, 1999). Finally, the Problem Diagnosis approach proposes to focus on software process issues and problems experienced by key organizational players in order to build support and commitment for improvement initiatives (Iversen et al., 1999).

All of the above methods and tools focus on the assessments used to initialize an improvement program and evaluate results. Such assessments are, however, disjoint from day-to-day development activities and they are not designed for ongoing monitoring of improvement projects. They are, therefore, less suited for practitioners and local managers who need to verify that improvement projects progress according to plan towards set goals (Arent et al., 2000; Daskalantonakis, 1994). Consequently, a third group of research focuses on tools and techniques aiming to provide rapid, low-cost, low impact assessments and feedback to SPI projects. Daskalantonakis reports how Motorola used a “progress assessment” technique to assess software projects according to the SW-CMM, Version 1.1 (Paulk et al., 1993) thereby providing useful information about the overall SPI project’s progress (Daskalantonakis, 1994). The technique uses (internal) facilitators to support the assessment and was used quarterly over a period of two years in one of Motorola’s divisions. A similar approach was used in the Danish subsidiary of L.M. Ericsson, but supplemented with so-called Ultra Light Assessments (ULA) performed monthly by project members themselves. The ULA uses an Excel spreadsheet with questions pertaining to the key practices of CMM level 2, and each answer is color coded (red, yellow, green) to illustrate a project’s degree of compliance with level 2 processes. The change over time in

the distribution of red, yellow and green answers gives an immediate overview of improvements (or the opposite) to a project's work practices. A ULA can be completed by a project manager and (part of) his team in ½-1 day. Lessons from both L.M. Ericsson and Motorola show that such frequent progress monitoring and reporting support commitment, participation, and learning among practitioners in SPI projects. Furthermore, management receives frequent reports and feedback about the overall SPI status and progress (Daskalantonakis, 1994; Arent et al., 2000).

The EBAT tool described in this article can, similarly to the ULA, be used for regular and project level assessments of practices against a maturity modelⁱⁱ and thus help monitor and guide SPI projects. In this paper we present results from its use in two different organizations and (in one case) over a prolonged period of time. The present article, therefore, extends previous research through a longitudinal study and an inter-organizational comparison of the effects of using the tool.

3. The EBAT tool

EBAT (Electronic Based Assessment Tool) is a semi-automated self-assessment tool that can be used to measure any systems development unit's degree of CMMI level 2 compliance with minimal tailoring of the tool.ⁱⁱⁱ Basically, EBAT consists of a web-based questionnaire and a calculation module that enables process measurements to be performed automatically, thereby establishing a maturity profile of the systems development unit being investigated.

CMMI level 2 targets the project level of software and systems development in the sense that the process areas address project management related concerns and issues. In keeping with this focus, EBAT was developed for use in projects with project managers and project participants as the target group, i.e. respondents. However, there is nothing to prevent the tool from being used to assess other organizational units against the same requirements confronting any CMMI level 2 project. Thus, EBAT has on occasion been used to take a 'temperature' reading of a department's state of health in terms of process maturity across projects.

3.1 History

EBAT was originally developed in Systems Inc. (see section 5.1) because of a need for swift data collection and data processing when assessing the maturity of software engineering practices (as defined by the CMM) through questionnaires. Existing questionnaires like the Questionnaire Based Assessment method (Arent et al., 1996) and the Flexible Assessment Questionnaire Tool (Vestergaard et al., 1998) were paper-based, so the first logical step was to make an electronic equivalent. And since the data to be collected would be stored in a database, the

next logical step was to automate the calculation of the degree of process maturity, so that maturity profiles for each unit of analysis (whether it be an entire development department, a single project group, or some other unit) could be generated effortlessly. The basic idea was to obtain a detailed and valid picture of the degree of CMM compliance (the degree to which software engineering practices meet with the process requirements of the CMM) with as little manual data processing as possible. Later it was decided to revise and update the tool to include not only software engineering but also systems development practices mirroring the replacement of CMM by CMMI by the SEI. EBAT has undergone a number of other changes and modifications since its original inception, including tailoring the questionnaire to fit the different roles in a project, e.g. project manager and systems developer.

3.2 Types of questions

The questionnaire consists of different categories of questions corresponding to the process areas of the maturity model, e.g. project planning, requirements management, and configuration management. The questionnaire includes more than 200 questions covering both the specific and generic practices of the CMMI. The questions take the form of scenarios. Each question contains two scenarios, one of which describes the systems development ideal as set forth by the CMMI, whereas the other describes 'poor' practice. The respondent is asked to judge (using a Likert scale) which of the two scenarios best corresponds to the systems development practice of his or her project group, or some other unit to which the respondent belongs.

Figure 1 shows an example of a question. The question is one of many within the process area of Project Planning (PP) that covers one of the specific practices at CMMI level 2.^{iv}

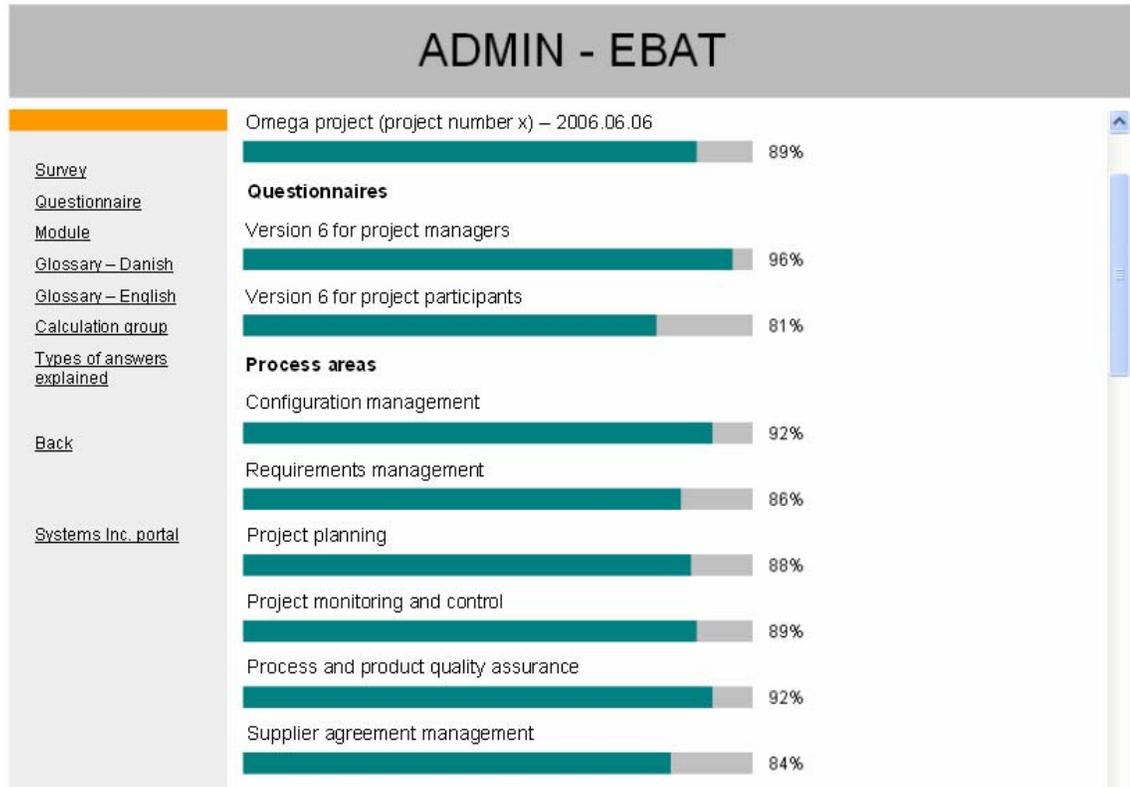
Figure 1: Example question

The screenshot shows a web-based questionnaire titled "EBAT". At the top, there is a grey header with the text "EBAT". Below the header, there is a navigation bar with an orange "Back" button on the left and a "Print this questionnaire" link on the right. The main content area contains a question: "2. To what extent have estimates of the time needed to complete all project related tasks been calculated?". Below the question are two options: "A: Time estimates have been established for all main tasks and sub-tasks." and "B: Time estimates have not been established.". To the left of these options is a vertical list of radio buttons for response selection: "Like A", "Mostly like A", "Mostly like B", "Like B", "Don't know", and "Not relevant". To the right of the radio buttons is a "Comments:" label followed by a text input field with a vertical scrollbar. In the bottom left corner of the main content area, there is a link labeled "Systems Inc. portal".

An input field for comments is attached to each question inviting respondents to elaborate and justify their answers. This enriches the data by helping managers and others to understand certain patterns or results emerging from the assessments.

By computing and comparing the answers for each project group (or the like) to the process requirements specified by the CMMI it is possible to not only identify strengths and weaknesses of existing practices but also to calculate a CMMI level 2 maturity rating for the project in question. An example of the overall maturity profiles of a sample project is illustrated in figure 2.

Figure 2: Example maturity profile



4. Research method

This article is the result of a longitudinal study of the long-term use of EBAT in SPI projects. In one of the two organizations included in the study the tool has been used regularly from the fall of 2004 until the fall of 2006 as part of ongoing SPI efforts. During this time period an estimated 100 assessments have been performed to evaluate the process maturity and process implementation progress in development projects. One of the authors participated in the company's Software Engineering Process Group (SEPG) and was responsible for the maintenance and deployment of the tool when needed.

In the second organization, assessments were performed over a shorter time period to determine the overall maturity of a development department. In both organizations a number of data sources were used not only to calibrate the tool but also to evaluate its usability and accuracy as an assessment tool. These data sources are the empirical basis for this paper. The data sources are: questionnaire

comments provided by respondents, interviews with respondents, minutes of meetings, audio recordings from SEPG meetings, audits with the purpose of ascertaining the validity of the assessment results, introductory meetings to familiarize respondents with the questionnaire, and presentations of assessment results. In these different fora, project managers, project participants, and representatives of management have had the opportunity to voice concerns, reservations, criticism, suggestions for improvement, and praise. Their comments and feedback have subsequently been used in analyses of the assessment results. These analyses have in part been conducted during the SPI process itself with input from different stakeholders, including the SPI manager in one of the two companies. Their contributions to these analyses have not only been instrumental in determining the reliability and validity of the assessment results that EBAT produce, but they also lend credit to the reported findings, since people with inside knowledge of the companies have influenced and validated the findings.

5. Using the tool

EBAT has been used in SPI projects in two different organizations: Systems Inc., an independent company, and Software Consultants, a subsidiary of a larger engineering and construction consultancy firm.^v

5.1 Systems Inc.

Systems Inc. is a large Danish systems development company that offers mission critical solutions on a global scale. The company spans a number of different industries and application areas, including space solutions, radar systems, and solutions for defense and aerospace applications. In 2004 Systems Inc. initiated a both ambitious and company-wide process improvement project under the name of Business Process Improvement Project (BPIP). The reasons for undertaking this endeavor were numerous. However, future potential market opportunities in the United States made the CMMI the obvious choice of SPI model, and CMMI level 2 process compliance was chosen as the immediate project goal. Management at Systems Inc. quickly decided that having reliable measurements of progress were key to being able to manage the process improvement project effectively. EBAT has been an integral part of the measurement strategy, and the tool is still used for determining whether systems development practices at the project level are compliant with both required and expected CMMI model components.

Systems Inc. management chose a process improvement strategy that emphasizes measurements as a key driver in implementing new and improved processes. Measurements have been used regularly and systematically to ensure that implementation targets are met (target levels have been set for each process

area), and non-compliance issues are reported. The tool has been used for more than 2 years, and the validity of the results has been continuously evaluated during this time period. Since project kick-off, EBAT has been used to assess the maturity of systems development processes of over 30 new and ongoing projects. Measurements have been performed on average every 3 to 4 months to evaluate the progress of putting new CMMI level 2 processes into practice. During this period EBAT has demonstrated its usefulness by providing a longitudinal view of the evolution of process maturity at the project level. The tool has rendered improvements readily visible, and when expected changes have failed to occur, EBAT has been used to identify weak spots and areas for improvement in the projects' practices. Today, relying in part on the assessment results, management seems confident that Systems Inc. is operating at CMMI level 2, and at present EBAT is primarily being used to ensure that practices do not degenerate, but that processes are being institutionalized as the 'way we do business around here'.

Management has valued EBAT as a catalyst and driver in BPIP. EBAT is viewed as a process 'temperature gauge', i.e. as a means of getting a snapshot of the development practices of each project, that can be used as a basis for deciding on corrective actions whenever results fall short of expectations in terms of process improvements. Some other qualities that have been attributed to EBAT include its educational properties, meaning that the tool is perceived as instrumental in teaching project managers and participants about best practices as described by the scenarios for each question. On the other hand EBAT has received mixed reviews among project managers and participants. Some people have been put off by the time needed to fill out the questionnaires, and others have found several of the questions too abstract or difficult to understand. Still others, typically project managers, have welcomed the regular 'health check' of projects.

Besides having to contend with scattered resistance to the tool itself, other important challenges have emerged through the process of using and adapting EBAT to suit the needs of the organization. For example, repeated measurements have on a few occasions led to mindless and superficial answers being given to the questions on the questionnaire. Also, maintaining a tool that is continuously updated to accommodate employee suggested enhancements as well as performing analyses and providing feedback on assessments have resulted in higher assessment costs than initially expected. In section 6 these and other lessons learned in using an assessment tool like EBAT will be discussed.

5.2 Software Consultants

Software Consultants began as the IT department of a construction and engineering consultancy group, but has been formed into an independent subsidiary. The company supports and develops information systems for some of

the biggest Danish companies as well as central and local government institutions and authorities.

In May 2005 an outside consultant carried out a CMMI light assessment at Software Consultants. Three selected projects participated, and the company was assessed at level 1 on the CMMI scale. In the fall of that year Software Consultants formulated a vision and a strategy plan for 2005-2008 in which software process maturity was made an explicit goal.

In February 2006 two of the authors performed a preliminary investigation into one department of Software Consultants using EBAT and interviews with project managers and developers. 28 employees from four different projects were asked to complete the online survey and 22 completed it. The results from the survey showed that Software Consultants was still a level 1 (CMMI) organization in spite of a year's SPI effort.

Comments from the interviews following the EBAT measurement indicate that developers and project managers saw the survey itself as a vehicle for learning about software processes and maturity and as an opportunity for reflecting on their current practices. They did not, however, initiate improvements themselves, but expected management to take responsibility for improvements based on the findings from the survey.

The survey itself was carried out with little organizational impact and cost, although respondents were unfamiliar with several terms in the questionnaire and therefore needed further instruction and guidance.

6. Discussion

The two cases show that an online tool like EBAT can provide insights and reflections about an organization's software practices that are considered valid and helpful by developers, project managers, and management. The relatively short time needed to fill out the questionnaire (1-2 hours) and the immediate feedback in the form of a maturity profile of the organizational unit under investigation makes such a tool a useful instrument for repeated assessments in an ongoing SPI initiative.

We observed that the assessment tool was not in itself an independent driver in the SPI projects, i.e. the tool did not by itself sustain process improvement momentum and carry the process of SPI forward. At Software Consultants respondents accepted the assessment results, but relied on management initiative to start improvements. At Systems Inc. project-by-project assessment reports and other forms of status reporting have ensured management attention and pressure that has pushed the SPI efforts forward. These findings correspond to results from previous studies of project level tool based assessments (Arent et al., 2000; Daskalantonakis, 1994).

Our longitudinal study revealed, however, other costs and challenges that must be considered if an assessment tool is to be used repeatedly over a long period of time. These costs and challenges pertain to tool tailorization, training of respondents, and communication of results. Also, the initial learning and reflection over own practices resulting from using the tool may be substituted by wear-out and routine responses which leads to less reliable results in the long run.

6.1 Even a generic assessment tool must be tailored

EBAT can be used in its generic form to obtain results that are recognized as valid by the people being investigated, but richer results are obtained if the wording of the questions in the questionnaire is adapted to the jargon and terminology used by the employees themselves.

When EBAT or any other similar tool is used not only to create snapshots that highlight strong and weak points of current practices, but is used proactively to guide improvement efforts which requires repeated use of the tool, it proves beneficial to adapt the generic questionnaire to the jargon of that particular organization. At Systems Inc. much effort has been put into changing for example the wording of the questions. The word "review" provides an example of the need for adapting the terminology. Many employees at Systems Inc. associate the word "review" with a technical inspection of some sort. However, many practices in the CMMI, on which the phrasing of the questions in the questionnaire is based, attach a different meaning to the word "review", e.g. GP 2.10: "Review Status with Higher Level Management" (CMMI Product Team, 2002). Consequently, other words had to be used depending on the underlying meaning of the question. To avoid questions being misunderstood, pilot assessments were performed to identify key words and concepts that were interpreted differently than intended. Furthermore, several project managers and project participants were interviewed and asked to interpret each of the questions in the questionnaire in order to identify unintelligible and ambiguous questions. Lastly, questionnaire comments have been collected continuously and used to rephrase questions as needed.

In addition to tweaking the wording of the questions, a group was tasked with the responsibility of trimming the questionnaire so that non-essential questions were eliminated. Based on an examination and interpretation of the CMMI, this group was able to tailor the questionnaire to different project roles, e.g. project managers and project participants. Consequently, many questions that were previously seen as irrelevant to some respondents, e.g. questions regarding a project manager's responsibilities being addressed to a systems developer, have been eliminated. This adaptation and tailoring of the questionnaire with the purpose of reducing annoyance and aversion among respondents have taxed a lot of internal development resources. Since the division of roles and responsibilities differ from one company to another, similar costs of tailoring an assessment tool, are highly likely in other organizations too.

6.2 The costs of using an assessment tool are partly hidden

Calculating the direct costs of using an assessment tool like EBAT, e.g. the man-hours needed by respondents to fill out the questionnaires, is pretty straightforward. Other costs associated with process assessments are, however, less tangible and are in fact hidden from view.

First, in both cases resources were needed for training (teaching the respondents how to go about answering the questionnaire). This of course increases the cost of using the tool, but may also help strengthen the reliability of the results. Due to the complexity of the questionnaire in the sense that respondents are being asked to compare different scenarios with existing work practices by using a number of predefined answers, it is necessary to instruct the respondents in how to answer the questions. Our research indicates that it is not enough to inform respondents in the introductory notes to the questionnaire, because they will assume they know how to take the survey. Consequently, at Systems Inc. a number of introductory meetings were held prior to sending out questionnaires. Judging from the questions raised at those meetings and misunderstandings that have been corrected, it is safe to say that such meetings increase the reliability of the collected data. However, such meetings are yet another factor contributing to an increase in the costs of using EBAT. Similarly, at Software Consultants it was necessary to instruct and help respondents understand unfamiliar terms used in the questionnaire.

Second, while assessment tools like EBAT may provide quick and, on the face of it, relatively inexpensive snapshots of current practices, using such tools as levers or drivers in SPI projects may increase the operating costs considerably. As previously mentioned, EBAT has been used every 3 to 4 months at Systems Inc. to evaluate the progress in implementing new standard processes and to suggest areas for improvement. In order to be able to supply each project being assessed with as much valuable information as possible, it proved necessary to tailor an otherwise generic approach to assessing systems development practices. In addition to the standardized reports produced by EBAT showing maturity level ratings and degrees of goal compliance for each of the CMMI level 2 process areas, the need for project specific analyses of the questionnaire data arose. Such generic reports do not pinpoint the source of problems when projects fail to comply with newly defined processes and work descriptions. An example may help to illustrate the point. Looking at Project Planning, a project is required to develop a project plan. Specific goal 2 (a required model component) reads: "A project plan is established and maintained as the basis for managing the project" (CMMI Product Team, 2002). However, knowing that a particular project does not satisfy this requirement does not tell us why. Perhaps project risks have not been adequately identified (specific practice 2.2-1), or maybe a data management plan has not been prepared (specific practice 2.3-1). Thus, to be able to provide constructive feedback to the projects in order that they might improve their

practices, measurements of these so-called specific practices have been implemented at Systems Inc. The unforeseen need for implementing these measurements and for preparing customized assessment reports to each project has substantially increased the cost of using EBAT at the company.

A final source of increased costs is the need to adapt the form and content of the assessments to the process implementation strategy. At Systems Inc. individual implementation plans for each project spelled out when compliance was expected for which processes. Due to the variation in these implementation plans, questionnaires consisting of different subsets of questions were needed at different times, e.g. if a project opted not to comply with certain requirements management processes at the time of an assessment, questions addressing those practices would be removed to reduce the time needed to complete the questionnaire. Needless to say, this kind of tailoring increases the time needed to prepare a questionnaire as part of an assessment and thereby the costs.

6.3 Short-term learning – long-term wear out

Assessments are a useful learning vehicle in SPI as they introduce the organization to terms, concepts, and best practice descriptions that trigger reflections on existing practices. However, repeated assessments using a tool like EBAT bear the risk of creating routinization and wear out among respondents. First, the sheer size of the questionnaire makes frequent use of the tool undesirable. Second, reactions from Systems Inc. employees suggest that if respondents recognize and remember questions from a previous survey, they become less attentive and less motivated to answer the questions faithfully. Several respondents have admitted to switching on 'the autopilot' when filling out the questionnaire, because they could recall the questions and had beforehand formed opinions regarding the answers. Triggered by surprising assessment results, the responses of some project members were probed whereby the claim about routinization was substantiated. Looking at the patterns of answers some interesting observations were made. Examples of respondents having submitted identical answers to consecutive questions (e.g. a respondent answering "not applicable" to numerous questions in a row) were identified. In such instances a 'red flag' was raised and that person was asked to clarify the rationale behind these answers. Failure to provide convincing arguments left the impression that some people were taking a short cut to finish the questionnaire as quickly as possible. Others hinted that they had answered "don't know" (with unfortunate consequences when calculating the maturity ratings) in sheer irritation of being confronted with the same questions again. Using facilitators as a supplement to the questionnaire itself, as reported in (Daskalantonakis, 1994), may serve to reduce this problem, but this will add to the overall costs of the assessments.

7. Conclusion

Assessment tools such as EBAT are a means to low cost and low impact assessments of software/systems development processes. Thus, these tools are a useful way to repeatedly gauge the state of an ongoing SPI project and hence support the SPI effort.

Our findings suggest, however, that in the long run driving an SPI project by way of an assessment tool carries hidden costs and challenges. A single tool based assessment is cheap and can be performed in a short time, especially when compared to other appraisal methods, but when a large number of assessments are conducted on a regular basis, it becomes a time-consuming endeavor. The tool must be tailored to the organization's needs and continuously adjusted, as the SPI project evolves, and time must be set aside for sending out questionnaires and reminders, analyzing and interpreting the results, and providing feedback based on the answers. Also, repeated assessments may reduce the reliability of answers due to routinization and wear out. This problem may be countered with the use of facilitators which, however, adds to overall costs. Therefore, assessment tools like the one reported here may be an inexpensive way of getting a feel for the strengths and weaknesses of an organization's development practices, but it is far more demanding to use the tool as a lever in SPI.

References

- Aaen, I., Pries-Heje, J. (2004). "Standardising Software Processes - An Obstacle for Innovation?", *Proceedings of IFIP WG 8.6 Seventh Working Conference on IT Innovation for Adaptability and Competitiveness*, pp. 117-133.
- Aaen, I. (2002). "Challenging Software Process Improvement by Design", *Proceedings of ECIS 2002 - The Xth European Conference on Information Systems*, vol. 1, ECIS 2002, pp. 379-390.
- Arent, J., Andersen, C. V., Iversen, J. H., Bang, S. (2000). "Project Assessments: Supporting Commitment, Participation, and Learning in Software Process Improvement", *Proceedings of the 33rd Annual Hawaii International Conference on System Sciences (HICSS33)*.
- Arent, J., Iversen, J. (1996). *Udvikling af metode til modenhedsmålinger i software-organisationer baseret på the capability maturity model*. Aalborg Universitet, Aalborg.
- Bach, J. (1995). "Enough about Process: What We need are Heroes", *IEEE Software*, vol. 12, no. 2, pp. 96-98.
- Bollinger, T. B., McGowan, C. (1991). "A Critical Look at Software Capability Evaluations", *IEEE Software*, vol. 8, no. 4, pp. 25-41.
- Cater-Steel, A., Toleman, M., Rout, T. (2006). "Process improvement for small firms: An evaluation of the RAPID assessment-based method", *Information and Software Technology*, vol. 48, no. 5, pp. 323-334.
- CMMI Product Team. (2006). *CMMI for Development, Version 1.2*. Software Engineering Institute, Pittsburgh, PA.

- CMMI Product Team. (2002). *CMMI for Systems Engineering / Software Engineering / Integrated Product and Process Development / Supplier Sourcing, Version 1.1, Staged Representation (CMMI-SE / SW / IPPD / SS, V1.1, Staged)*. Software Engineering Institute, Pittsburgh, PA.
- CMMI Product Team. (2001). *Appraisal Requirements for CMMI, Version 1.1 (ARC, V1.1)*. Software Engineering Institute, Pittsburgh, PA.
- Daskalantonakis, M. K. (1994). "Achieving Higher SEI Levels", *IEEE Software*, vol. 11, no. 4, pp. 17-24.
- Dunaway, D. K., Masters, S. (2001). *CMM-Based Appraisal for Internal Process Improvement (CBA IPI) Version 1.2 Method Description*. Software Engineering Institute, Pittsburgh, PA.
- Gorschek, T., Wohlin, C. (2004). "Packaging software improvement issues: a method and a case study", *Software - Practice & Experience*, vol. 34, no. 14, pp. 1311-1344.
- Gresse von Wangenheim, C., Varkoi, T., Salviano, C. F. (2006) "Standard Based Software Process Assessments in Small Companies", *Software Process: Improvement and Practice*, vol. 11, no. 3, pp. 329-335.
- Haase, V., Messnarz, R., Koch, G., Kugler, H. J., Decrinis, P. (1994) Bootstrap: "Fine-Tuning Process Assessment", *IEEE Software*, vol. 11, no. 4, pp. 25-35.
- Hansen, G. I. (2005). "Three types of Software Development Organizations – one SPI strategy?", *Proceedings of the 28th Information Systems Research Seminar in Scandinavia IRIS 2005*.
- Humphrey, W. S. (1990). *Managing the Software Process*. Addison-Wesley, Reading, MA.
- Hunter, R., Robinson, G., Woodman, I. (1997). "Tool Support for Software Process Assessment and Improvement", *Software Process: Improvement and Practice*, vol. 3, no. 4, pp. 213-223.
- ISO/IEC JTC1/SC7/WG10. (1998). *Software Process Assessment - Part 5: An assessment model and indicator guidance*. International Organization for Standardization, Geneva, Switzerland.
- Iversen, J., Nielsen, P. A. and Nørbjerg, J. (1999). "Situated Assessments of Problems in Software Development", *Database for Advances in Information Systems*, vol. 30, no. 2, pp. 66-81.
- Iversen, J., Johansen, J., Nielsen, P. A., Pries-Heje, J. (1998). "Combining Quantitative and Qualitative Assessment Methods in Software Process Improvement", *Proceedings of the 6th European Conference on Information Systems*, vol. 1, pp. 451-466.
- Kautz, K. (1999). "Making Sense of Measurement for Small Organizations", *IEEE Software*, vol. 16, no. 2, pp. 14-20.
- Kautz, K. (1998). "Software process improvement in very small enterprises: does it pay off?", *Software Process: Improvement and Practice*, vol. 4, no. 4, pp. 209-226.
- McFeeley, R. (1996) *IDEAL: A User's Guide for Software Process Improvement*. Software Engineering Institute, Pittsburgh, PA.
- Paulk, M., Curtis, B., Chrissis, M., Weber, C. (1993). *Capability Maturity Model for Software (Version 1.1)*. Software Engineering Institute, Pittsburgh, PA.
- SEI. (2005). *SW-CMM Maturity Profile September 2005 Report*. Software Engineering Institute, Pittsburgh, PA.
- Vestergaard, C. A., Kristensen, L. (1998). *Diagnosticering i forbindelse med softwareprocesforbedring: udvikling af en spørgeskemabaseret metode baseret på CMM niveau 2 til diagnostisering af softwareprocessen*. Aalborg Universitet, Aalborg.

Notes

- ⁱ Also, by all accounts the tool meets the requirements for a Class C appraisal as specified by the Appraisal Requirements for CMMI, Version 1.1 (ARC, V1.1) though maturity ratings are not expected of a Class C appraisal (CMMI Product Team, 2001).
- ⁱⁱ EBAT is, however, based on the CMMI whereas the ULA uses the CMM.
- ⁱⁱⁱ EBAT is based on version 1.1 of the CMMI-SE/SW (CMMI Product Team, 2002). It remains to be clarified whether the tool is compliant with version 1.2 of the CMMI for Development (CMMI Product Team, 2006).
- ^{iv} In this case SP 1.2-1 (Establish estimates of work product and task attributes): Establish and maintain estimates of the attributes of the work products and tasks (CMMI Product Team, 2002).
- ^v Not the real names of the companies.

Grounded Theory – the two faces of the methodology and their manifestation in IS research

Riitta Hekkala

University of Oulu, Finland

riitta.hekkala@oulu.fi

Abstract. The understanding of grounded theory is dependent on an awareness of the method's/methodology's ontological, epistemological and methodological perspective. The research paths of Glaser and Strauss, the original developers of the grounded theory methodology, have diverged since the early days of the approach. Little attention has been paid in information systems (IS) literature on this split of ideas. Many researchers have used the grounded theory method/methodology in their IS studies very ingenuously without paying much attention to the school of thought whose ideas underlie their research. This article highlights the background of grounded theory and explores, besides the development and coexistence of the two schools of thought, their most essential ontological, epistemological and methodological differences. In addition, the article seeks to point out that the grounded theory research of the IS field has rarely discussed the ontological and epistemological differences of the two schools and that the grounded theory approach has been applied in IS research in conflicting ways. The article also considers the question of inductivity that originally pertained to the data analysis procedure of the methodology but has since become an issue between its developers.

Keywords. grounded theory, Glaserian approach, Straussian approach, grounded theory in IS studies.

Introduction

Grounded theory has been a frequently used research method in various disciplines, especially in sociology, psychology and health sciences, ever since its development. Since the beginning of the 1990s it has been popular also to apply it in the field of IS and this seems to be a growing trend (see e.g. Pries-Heje, 1992, Orlikowski, 1993, Pandit, 1996, Myers, 1998, Hughes & Jones, 2003, Goede & Villiers, 2003, Pace, 2004, Urquhart, 1997, 1999, 2001). The grounded theory methodology was developed in the late 1960s for studies that sought to open up new perspectives on the phenomena under investigation. The approach was tailored for research domains with little theory or for the study of action that takes place in a new situation with a high probability of unanticipated factors (Glaser & Strauss, 1967). Grounded theory methodology was conceived to be a way of thinking and conceptualising the data. The methodology was described as a data-based formulation of theory where the main arguments of the study arise from the data. In other words, the starting point was to let the data tell the story on the basis of which a theory was to be formulated.

At a later stage, the research paths of the developers of the grounded theory methodology diverged, partly in a radical way, into Glaserian inductive theory formation (Glaser, 1978, 1992, 1994) and Straussian inductive-deductive theory formation (Strauss, 1987, Strauss & Corbin, 1990, 1994). However, no fundamental research has been conducted on the differences of these two schools of thought in the field of IS science. In the IS field, there are numerous studies that do not refer to the existence of the two schools of thought or to the later works of Glaser (1978, 1992, 1994) in any way (see e.g. Oliphant & Blockley, 1991, Pries-Heje, 1992, Ellis, 1993, Orlikowski, 1993, Calloway & Knapp, 1995, Grinter, 1996, Lubbe, 1996, Galal & McDonnell, 1997, De Vreede & Jones & Mgaya, 1999, Lubbe & Remenyj, 1999, Pandit, 1996, Yoong, 1999, Lehnmann, 2001, Rowlands, 2005).

Yet, to understand and to be able to apply the grounded theory method/methodology in an appropriate way, we must be aware of its ontological and epistemological basis and the subsequent assumption developed from it (see also Urquhart, 2001). The original grounded theory methodology is no more backed up by both of its developers. The grounded theory methodology has become a methodology of special interest because it has been applied in so many different ways, for instance in the field of ISs. The study designs vary from a very positivistic perspective to a humanistic one. Almost all grounded theory studies in the field of ISs science are based on the inductive-deductive approach of the Straussian school even though such affiliation is not acknowledged. Urquhart (2001) have noticed too that most people in IS research area think that Strauss and Corbin (1990) is the definitive book on grounded theory.

In this article, I refer to grounded theory as a method or methodology for two reasons. First many IS researchers introduce grounded theory as a method (e.g.

Urquhart, 2002, Jones & Hughes, 2004, Fernández, 2004a) or methodology (e.g. Orlikowski, 1993, Urquhart, 2000, Goede & Villiers, 2003, Goulding, 1999). The above authors do not, however, follow any particular logic when referring to grounded theory either as a method or a methodology. The second reason for discussing grounded theory as a method or methodology arises from Glaser's (1994) criticism of Strauss and Corbin (1990) in which he points out that the latter authors' approach cannot be regarded a methodology. For Glaser it is only a method that produces a detailed but forced and predetermined conceptual description of the object of the study. This question of deductivity and inductivity has become focal in the discussion among the developers of the grounded theory approach (see also Urquhart, 2001).

One aim of the present study is to stimulate discussion among the IS researchers on the deductive and inductive processes involved in the grounded theory approach so that those planning to initiate grounded theory research would be able to start from clear premises. Secondly, this study aims to highlight the distinctive ontological and epistemological differences between the two grounded theory schools of thought and to explore how such differences have been taken into account in ISs research. When discussing these ontological and epistemological questions I seek to point out how the choice of the school of thought may affect, for instance, the progress of the research process. An awareness of the differences between the schools of thought may help IS researchers choose a methodological approach most appropriate for their study. Moreover, a clear distinction between the different schools of thought is likely to increase the validity of the study. It is also expected to facilitate the assessment of the reliability of the study.

In Section 2, a brief account of the background of grounded theory methodology is provided. This is followed by an introduction to the development and current state of the two methodological schools. After that, I discuss the distinctive ontological and epistemological differences of the Glaserian and Straussian schools, which have been almost completely ignored in IS grounded theory studies (see also Urquhart 2001). In the later writings of the original developers conflicting issues relate not only to the discussion of the research problem and the object of study but also to that of data analysis and the subsequent results. In Section 3, a review of IS grounded theory studies is conducted. This article will bring out important considerations which will indicate a need for grounded theory related paradigmatic discussion in the field of ISs research.

Grounded theory – premises and development of the methodology

Grounded theory – an overview of the background

The roots of the grounded theory methodology lie in social sciences. Two sociologists, Glaser and Strauss developed the grounded theory methodology in the 1960s and introduced it in their book “Discovery of Grounded Theory: Strategies for qualitative research” published 1967. Grounded theory methodology was intended for inductive theory formation on the basis of phenomena and social processes arising from the data.

Goulding (1999, p. 6) pointed out that the development of grounded theory was an attempt to avoid highly abstract sociology and was part of an important growth in the application of qualitative analysis in the 1960s and 1970s. The main impetus behind the movement was to bridge the gap between theoretically ‘uninformed’ empirical research and empirically ‘uninformed’ theory, by grounding theory on data. It was written in part as a protest against what the authors viewed as a rather passive acceptance that all the ‘great’ theories had been discovered and that the role of research lay in testing these theories through quantitative ‘scientific’ procedures.

Grounded theory methodology has been widely used in various disciplines such as sociology, health sciences, political sciences, psychology, and education (see e.g. Haig, 1995). The methodology is applicable to largely uninvestigated fields with little existing theory. It can also be used when a new perspective to a phenomenon is sought (see Glaser & Strauss, 1967). The grounded theory methodology can be adopted when the aim of the study is to create new theoretical structures, identify new concepts, specify previous concepts or theories, or to define the core concepts relating to a research problem. (Glaser, 1978, 1994, Strauss & Corbin, 1998).

The general principles underpinning the grounded theory methodology include a coding procedure and analysis which are based on constant comparison and realised as simultaneous events in the research process. Data is not forced into any pre-existing categories and no part of it is ignored due to incompatibility with a predetermined theoretical model. The researchers start related literature reviews only after a tentative analysis of the data has been carried out by means of the comparative method. Once the interpretation of the target phenomenon has taken place, reading becomes an integral part of the comparative method. A precondition for the latter step is, however, that the need for reading arises from the data (Glaser & Strauss, 1967, p. 37).

Glaser and Strauss’s (1967) original comparative method is a 4-stage procedure in which theory building is initiated by coding. At the first stage, the items of data to be coded are incidents. Incidents are classified into as many categories as they seem to require. Coding is guided by the basic principle of the comparative method; when an incident is coded by assigning it a descriptive category it is compared to other similarly coded incidents. This results in an emergence of the distinctive theoretical properties of

the categories. Systematic recording of the observations constitutes an essential part of the methodology. In this way the categories undergo constant reviewing and modification during the coding process. (Glaser & Strauss, 1967, p. 105-107)

The second stage involves an effort to integrate the categories. The level of analysis changes from the comparison of incidents to the comparison of the categories. This is followed, at the third stage, by a specification of the theory. A comparison now takes place between the categories and the emerging theory. It is now the task of the researcher to identify the compatibilities of the data and describe it using a minimum number of categories. Reduction in the number of categories has a specifying effect on the emerging theory which is capable of explaining a growing amount of the data. A state of theoretical saturation is achieved when new incidents of the data can be accommodated into the existing categories of the model and they do not bring in any new information. At the fourth stage, a theory is formulated on the basis of the conceptual categories identified in the course of data analysis. (Glaser & Strauss, 1967, p. 109-115)

Grounded theory and the emergence of two schools of thought: From ontology to epistemology

Glaser's and Strauss's views of the premises of the grounded theory were later separated and referred to as Straussian inductive-deductive theory formation (Strauss, 1987, Strauss and Corbin, 1990, 1994) and Glaserian inductive theory formation (Glaser, 1978, 1992, 1994). A comparison of Glaser and Strauss's (1978) original 'Discovery of Grounded Theory' and Strauss and Corbin's (1990) 'The Basics of Qualitative Research' demonstrates not only the changes but also the distinct differences in the perception of the methodology between the two authors since its inception. There are differences in terminology, and Strauss's version of the method has been reworked to incorporate a strict and complex process of systematic coding. (see also Goulding, 1999.) The differences between the Glaserian and Straussian schools are distinct from both the ontological and epistemological perspectives (see also Urquhart 2001).

The grounded theory methodology is frequently seen to be an ontologically realistic research approach even though in logical terms this is not the case. There are differences in the way the object of study is perceived within the above two schools of thought. Moreover, the study procedure and the method of data collection vary in the two schools. The Glaserian approach (Glaser, 1992, p. 16, 101) uses systematically different methods to produce inductive theory from a substance field. According to the Straussian approach (Strauss & Corbin, 1990, 1994, p. 274), on the contrary, theory is perceived to develop through systematic data collection and continuous theoretical analysis. Thus the aim of the Straussian analysis is a verification of the hypotheses formulated on the basis of data analysis.

A description of the views of the school of thought whose methodology is applied constitutes an essential part of a qualitative grounded theory study. Grounded theory

methodology has traditionally been seen as inductive theory formation (Glaser & Strauss, 1967). Researchers using the grounded theory methodology frequently highlight inductivity as the essence of the method. For instance, Orlikowski (1993) points out that grounded theory is

“an inductive theory discovery methodology that allows the researcher to develop a theoretical account of the general features of the topic”

Orlikowski's paper arises from the Straussian line of thought as evidenced by the references and the discussion of the steps of data analysis.

The stress laid on induction is of interest in grounded theory studies because in the book published in 1990 Strauss and Corbin themselves do not actively advocate a separation from the original methodology and Glaser's views. When comparing their new book with previous literature on the topic (e.g. Glaser, 1978, Strauss, 1987), Strauss and Corbin (1990, p. 8) point out that there are only a few theoretical or methodological deviations. A special source of ambiguity is created when Strauss and Corbin (1990, p.8) recommend their book to those interested in inductively produced theory and state that the theory created using the grounded theory method is inductively inferred from the investigated phenomenon (Strauss & Corbin, 1990, p. 23). In their book from the year 1990, the authors are either not aware of their shift towards deduction or they want to expand the territory of induction towards that of deduction.

This debate between Glaser, and Strauss and Corbin has been described as 'a war of words between friends' (Melia, 1996). Glaser (1992) dramatically advocated deduction in his book 'Basics of grounded theory'. Strauss and Corbin (1994) responded by claiming that too strict an adherence to induction may result in sterile and dull research. Moreover, Strauss and Corbin (1994, p. 277) pointed out that Glaser and Strauss (1967) had underestimated the potential influence of existing theories and the undeniable fact that trained researchers are theoretically sensitised.

Glaser (1998), for his part, advises researchers interested in the grounded theory methodology to avoid Strauss and Corbin's (1990) book "Basics of Qualitative Research" because it produces, according to Glaser, forced and predetermined conceptual descriptions which, in spite of their sophistication, do not arise from the data. Glaser (1994) claims that for the above reason Strauss and Corbin's (1990) approach can only be referred to as a method, not a methodology.

The epistemological differences between the Glaserian and Straussian lines of thought become evident in considerations relating to the formulation of research questions. According to the Straussian school, research questions can be set beforehand, either as (externally) given, inspired by literature, or emerging from personal experience. Strauss and Corbin (1990, p. 37) stress the promoting effect of questions formulated from research problems. According to the above authors, the researchers make a contribution by bringing along their experience and erudition, because, as a result, existing theories inform the process of data analysis in a significant way.

Glaser (1978, p. 58), on the contrary, takes a critical attitude towards the use of categories that have been derived from pre-existing theories and interprets it as forced theory formulation and an abandonment of the principle of emergence. In Glaser's (1992) opinion, a predetermined research problem unnecessarily burdens the research process because the researcher is bound to ensure that the data contains an adequate number of instances of the problem. Glaser (1992) thinks that a focus on predetermined problems prevents the researchers from identifying real ones. Thus questions relating to the preconceptions of the researchers are not presented because problems are not determined prior to the process of data analysis. Moreover, according to Glaser (1992, p. 25), questions should never be asked directly from the interviewees because that would lay constraints on emergence.

For Strauss and Corbin (1990, 1994), theory generation involves the development of conceptual categories through systematic coding procedures (open, axial, and selective). During the coding, the constraints of the coding paradigm and the conditional matrix must be considered at all the levels of theory generations. Thus Strauss and Corbin (1994, p. 279) equate theories with the research process. When the circumstances change at any level of the conditional matrix, the effects are seen, according to Strauss and Corbin (1994), at the level of the validity of the theory.

Glaser (1992, p. 24), on the contrary, sees grounded theory research as the study of abstract problems and the related processes. Observations and ideas arising from the data guide conceptualization and theory generation around the core concept (see Glaser, 1992, p. 75). In the Glaserian way of thinking, the analyser does not have to find preconceived circumstances, consequences, strategies or relationships (Glaser, 1992, p. 103). In the Glaserian data analysis, analysis and synthesis take place simultaneously rather than sequentially because the methodology aims to find the core process.

The Glaserian process of data analysis differs from the Straussian one in terms of the steps included (e.g. the step of axial coding is missing). The process of constant comparison as described by Glaser combines open coding, selective coding, theoretical memos, sorting and sorting by existing theories. The process of data collection is guided by theoretical sampling. Theoretical sampling ends when each category is saturated, developed and integrated into the emerging theory (Glaser, 1992, p. 101-102). The epistemological foundations of the Glaserian grounded theory are manifested in inductive, data-based generation of theory as required by the original grounded theory methodology. Glaser has adhered more closely to the original requirements of the methodology than Strauss (1987), who accepts deductivity side by side with inductivity. The deductive approach enables the pre-research choice of theories and hypotheses.

The Grounded theory methodology and its conflicting interpretations in IS research

The grounded theory method/methodology has also been established in ISs research (see e.g. Pries-Heje, 1992, Orlikowski, 1993, Pandit, 1996, Myers, 1998, Hughes & Jones, 2003, Goede & Villiers, 2003, Pace, 2004, Urquhart, 1997, 1999, 2001). It has been frequently used in qualitative IS research and it is unquestionably one of the methods/methodologies which have been interpreted in various, and even conflicting ways (see also Goulding, 1999, Urquhart, 2001).

Several studies have indicated a need for a pragmatic discussion of the grounded theory method/methodology in the field of ISs science (see also Urquhart, 2001, 2002). During the recent few years, a number of ISs studies (Urquhart, 2001, 2002, Goulding, 2002, Mitrovic & Bytheway, 2006, Urquhart & Fernández, 2006) have focused on the myths and conflicting interpretations relating to the use of the grounded theory method/methodology. Urquhart (2001, 2002) has scrutinized the differences of the above two schools of thought.

Urquhart (2001) has asked that how we in the IS research community 'adapt' and use grounded theory? How could we evaluate a grounded theory study in ISs if we are not aware of these kinds of things like a philosophy? Urquhart (2002) has pointed out that grounded theory method has a long future in IS, because of its usefulness. So, the philosophy, practice, and the various uses in IS are well worth of debating.

The use of grounded theory in ISs studies

Varying assumptions and perspectives underlie the introduction of the grounded theory method/methodology in ISs studies. For example, according to Pries-Heje (1992) grounded theory provides a systematic technique for the development of substantive theory that meets the criteria of 'good' science while Orlikowski (1993) considers grounded theory worth adopting because its inductive, contextual and procedural characteristics are useful in investigating change. Urquhart (1999), for his part, points out that grounded theory offers well-signposted procedures which aim to produce a theory that is precise, rigorous and capable of replication. Rowland's (2005) target, on the contrary, is to provide guidance for carrying out research using an interpretive framework to build a theory of IS practice.

Moreover, Galal and McDonnel (1997) point out that grounded theory supports rigorous analysis of qualitative data and that it is adopted for the evolution of a first requirements model. For Jones and Hughes (2004) grounded theory is a method that provides practical guidelines and procedures for the collection and analysis of qualitative data. As the above discussion indicates, the grounded theory studies of the ISs field show different starting points and approaches to the application of the method/methodology.

Orlikowski's (1993) study, which won the MIS Quarterly's Best Paper Award for 1993, is in many respects a very good example of the grounded theory studies of the ISs field. It is significant for the introduction and promotion of the methodology in the field. It also serves as a representative example in that it does not consider the differences between the Glaserian and Straussian schools. One reason for the above omission lies, of course, in the fact that the developers of the methodology have also published works clarifying the differences of the two schools in the latter half of the 1990s. Orlikowski's study can be regarded as a well-implemented piece of grounded theory research, if the assessment is made from the perspective of the Straussian school. From the perspective of the Glaserian inductive methodology, however, the judgement would be the opposite.

Jones & Hughes (2004) made an attempt to show that there are inconsistencies in the ways the grounded theory method is understood and applied to ISs research. Even though they discussed several grounded theory studies conducted in the field, the account of the historical development of the methodology in the field of IS research remained one sided. Jones & Hughes (2004) do not highlight differences in the ideologies of the two schools even though they reflect on a number of questions relating to the use of the grounded theory in IS research.

In addition, the existence of the two schools of the grounded theory methodology is totally ignored in the IS grounded theory studies conducted by Oliphant and Blockley (1991), Pries-Heje (1992), Ellis (1993), Orlikowski (1993), Calloway and Knapp (1995), Grinter (1996), Lubbe (1996), Galal and McDonnel (1997), De Vreede, Jones and Mgaya (1999), Lubbe and Remenyj (1999), Pandit (1996), Yoong (1999), Lehnmann (2001), and Rowlands (2005). Instead, many researchers who use the grounded theory methodology are interested in developing it further (Orlikowski, 1993, Lehnmann, 2001).

Distinction of the schools of the grounded theory methodology in IS studies

The existence of the two schools of thought is brought up by Goulding (1999, 2002), Smit and Bryant (2000), Fernandez, Lehnmann and Underwood (2002), and Fernandez (2004a) but the authors do not discuss the differences of the schools. Fernandez et al.'s (2002) ECIS-paper, which proposes ways in which IS research can ease the practitioners' burden of adapting to changes by providing timely, relevant, and rigorous research, describes the grounded theory methodology as originally outlined by Glaser and Strauss (1967). The authors do not comment on the ideological differences of the two schools nor on the deeper philosophical issues of the methodology.

At a later stage, Fernandez (2004b) used in one of his studies (Using the Glaserian Approach in Grounded Theory Studies of Emerging Business Practices) the Glaserian perspective. In that paper he presented, however, a personal view of the grounded theory methodology which was generated by practising the methodology rather than by

philosophizing about it. Accordingly no comments were made on the differences between the two schools. Ambrose, Ramaprasad and Rai (2003) have also applied the Glaserian approach in their studies. Like Fernanedz, they do not state their position with respect to the differences of the Glaserian and Straussian lines of thought, nor do they ponder over the role of the Glaserian approach in their own study.

In the preceding section it was stressed that an awareness of the grounded theory schools and an ability to identify them and bring them up in the research process are of great significance from the point of view of the background commitments and reliability of research. In the field of ISs research, Goulding (1999, 2002) and Urquhart (2001, 2002) have provided some insight into the grounded theory paradigm, procedures and misconceptions but Goulding (1999, 2002) has analysed only a limited number of IS grounded theory studies. Goulding's (2002) book is directed at the ISs field of business economics and it offers an overview of the qualitative methods in general and locates grounded theory in this context. It compares and contrasts the various grounded theory approaches in an accessible manner and offers an in-depth case study for students and researchers to follow and use. It would be useful to incorporate in the discussion of the above perspectives an in-depth analysis of the philosophical issues underlying the method/methodology and an account of the applications of the method /methodology in various IS contexts.

Discussion

The grounded theory methodology was developed in the late 1960s to serve as a data-based tool of theory generation. The focal research challenge of the grounded theory methodology was defined to be a data-based (not previous research or theory-based) generation of theory which explains the target phenomenon and its changes in an optimal way. The development of the methodology was probably significantly affected by the fact that in the 1960s and 1970s sociological research and theory formation focused primarily on macro sociology. The sociological research of the 1960s and 1970s was mostly societal. (see Giddens, 1988, p.251.)

This article has highlighted the significance of recognizing the ideological differences between the Glaserian and Straussian grounded theory schools. These ideological differences have a bearing on both the ontological and the epistemological issues of the study. Recognition of the ideological differences of the two schools bears an influence on the decisions relating to the definition of research problems, collection and coding of data, use of existing theories, pre-research familiarizing with the subject field, and above all, inductive inference. Thus the ideological differences of the Glaserian and Straussian schools of grounded theory are reflected throughout the research process and the criteria for theory assessment.

In the field of ISs science, very little attention has been paid to the discussion and recognition of the above differences. This is certainly partially due to the fact that most ISs researchers have relied on Strauss and Corbin's (1990) book in which Strauss and Corbin do not themselves explicitly state a separation from the views of the original methodology or from those of Glaser, the original developer of the methodology. This may have provided the researchers with the conception that the grounded theory methodology would allow the use of both inductive-deductive and inductive processes of inference in the same study. Even though there are methodological discrepancies between Strauss and Corbin's (1990) book and Glaser and Strauss's (1967) original work that introduced the methodology, it is impossible to draw any exhaustive conclusions about the differences between Glaser's, and Strauss and Corbin's views on the basis of the above two books.

The above discrepancies drew the present author's attention to the fact that many reports on IS studies do not include any references to Glaser's (1987, 1992, 1994) later works (see e.g. Oliphant & Blockley, 1991, Pries-Heje, 1992, Ellis, 1993, Orlikowski, 1993, Calloway & Knapp, 1995, Grinter, 1996, Lubbe, 1996, Galal & McDonnel, 1997, De Vreede & Jones & Mgaya, 1999, Lubbe & Remenyj, 1999, Pandit, 1996, Yoong, 1999, Lehmann, 2001, Rowlands, 2005). Glaser's (1992, 1994) later works provide a clearer picture of the methodological conflicts and their severity. One reason for the fact that the studies of the early 1990s do not pay attention to Glaser's views may be that the upsurge of the literature highlighting the differences of the two grounded theory schools did not take place until the middle of the 1990s.

Glaser himself, however, made a clear distinction between his own and Strauss and Corbin's (1990) views in his book published in 1992.

Glaser's (1992, 1994) and Strauss and Corbin's (1990) methodological discussions strongly suggest that at least since the 1990s there has been no single way of conducting grounded theory research and that 'grounded theory' is not a sufficient description of any methodology used. Thus it is advisable to incorporate in the methodological label 'grounded theory' an additional modifier indicating the school of grounded theory methodology that is applied. An appropriate description should also be provided, if a combination of the two ideologies is applied. The question of Urquhart (2001) has been very important to the researchers that, can a researcher really claim to be using grounded theory if they use the 1990 Strauss and Corbin work as their sole guide, in the light of both a large body of work and this disagreement.

References

- Ambrose, P., Ramaprasad, A., and Rai, A. (2003). "Managing thin and thinly distributed knowledge in medical genetics using the Internet", *Logistic Information Management*, vol. 16, no. ¾, 207-214.
- Calloway, L. J., and Knapp, C. A. (1995). "Using grounded theory to interpret interviews", in M. K. Ahuja, Galletta, D. F., and Watson, H. J., *Proceedings of Information systems*, Pittsburgh, PA.
- Chenitz, W., and Swanson, J. (1986). "Qualitative research using grounded theory", in W. Chenitz, and Swanson, J. (eds) *From practice to grounded theory*, pp. 3-15, Addison-Wesley, Menlo Park.
- De Vreede, G. J., Jones, N., and Mgaya, R. (1999). "Exploring the Application and Acceptance of Group Support Systems in Africa", *Journal of Management Information Systems*, Winter 1998-99, vol. 15, no. 3, 197-212.
- Ellis, D. (1993). "Modelling the information-seeking patterns of academic researchers: a grounded theory approach", *Library Quarterly*, vol. 63 no. 4, 469-486.
- Fernandez, W. D. (2004a). "The Grounded Theory Method and Case Study Data in IS Research: Issues and Design". Paper presented at *the Information Systems Foundations Workshop: Constructing and Criticising*, Canberra, Australia.
(<http://scholar.google.com/scholar?hl=fi&lr=&q=cache:SSFTPhBeZ6kJ:teaching.fec.anu.edu.au/BUSN8018/GTM%2520and%2520Case%2520Study.pdf+> (Accessed 5 October 2006))
- Fernandez, W. D. (2004b). "Using the Glaserian Approach in Grounded Studies of Emerging Business Practices", *Electronic Journal of Business Research Methods*, vol. 2 no. 2, 83-94.
- Fernández, W. D., Lehmann, H. P., and Underwood, A. (2002). "Rigour And Relevance In Studies Of IS Innovation: A Grounded Theory Methodology Approach", in S. Wrycza (ed.) *Proceedings of the Tenth European Conference on Information Systems*, pp. 110-119, Poland, Gdansk.
- Galal, G. H., and McDonnel, J. T. (1997). "Knowledge-Based Systems in Context: A Methodological Approach to the Qualitative Issues", *AI & Society*, no. 11, 104-121.
- Giddens, A. (1988). "Goffman as a systematic social theorist", in P. Drew, and Wootton, A. (eds.) *Erving Goffman. Exploring the Interacion Order*, pp. 250-279, Polity Press, Cambridge.
- Glaser B. G. (1994). "The constant comparative method of qualitative analysis", in B. G. Glaser (ed.) *More grounded theory methodology: A Reader*, pp. 182-196, Sociology Press, Mill Valley, CA.
- Glaser, B. G. (1992). *Basics of Grounded Theory Analysis: Emergence vs. Forcing*. Sociology Press, Mill Valley, CA.
- Glaser, B. G. (1978). *Theoretical Sensitivity: Advances in the methodology of Grounded Theory*. Sociology Press, Mill Valley, CA.
- Glaser, B. G., and Strauss, A. L. (1967). *The Discovery of Grounded Theory*. Aldine Publishing Company, Hawthorne, NY.
- Goede, R., and Villiers C, De. (2003). "The Applicability of Grounded Theory as Research Methodology in studies on the use of Methodologies in IS Practices", *Proceedings of SAICSIT*, pp. 208-217.
- Goulding, C. (2002). *Grounded Theory. A Practical Guide for Management, Business and Market Researchers*. Sage Publications, London.

- Goulding, C. (1999). "Grounded Theory: some reflections on paradigm, procedures and misconceptions", *Working Paper Series. WP006/99*. Wolverhampton Business School, Management Research Centre. University of Wolverhampton.
- Grinter, R. E. (1996). *Understanding Dependencies: A Study of the Coordination Challenges in Software Development*, Ph.D. Thesis. Department of Information and Computer Science, University of California.
- Haig, B. D. (1995). *Grounded Theory as Scientific Method. Philosophy of education*. University of Illinois Press, Champaign, IL.
- Hughes, J., and Jones, S. (2003). "Reflections on the use of Grounded Theory in Interpretive Information Systems Research", *11th European Conference on Information Systems*, pp. 16-21, Italy, Naples.
- Jones, S., and Hughes, J. (2004). "An Exploration of the Use of Grounded Theory as a Research Approach in the Field of IS Evaluation", *Electronic Journal of Information System Evaluation, EJISE*, vol. 6 no. 1.
- Lehmann, H. P. (2001). "An object oriented architecture model for international information systems? Exploring a possible approach. Global Co-Operation in the New Millennium", *The 9th European Conference on Information Systems*, pp. 23-35, Bled, Slovenia.
- Lubbe, S. and Remenyi, D. (1999). "Management of information technology evaluation – the development of a managerial thesis", *Logistics Information Management*, vol. 12 no. 1/2, 145-156.
- Lubbe, S. I. (1996). *The assessment of the effectiveness of IT investment in South African organisations*. Ph.D. Dissertation. University of the Witwatersrand, Johannesburg.
- Mitrovic, Z. and Bytheway, A. (2006). "Community Informatics research and practice: A discussion of the status quo and the use of grounded theory", in A. Bytheway and Strümpfer, C. (eds.) *CIDC2006 Conference Paper*, pp. 229-246. University of Technology, Peninsula.
- Melia, K. M. (1996). "Rediscovering Glaser". *Qualitative Health Research*, vol. 6, no. 3, 368-379
- Myers, M. D. (1998). "Qualitative Research in Information Systems", University of Auckland, Auckland. Available from: <http://www.auckland.ac.nz/msis/isworld/index.html>. Updated 24 March 2006. [Accessed 30 September 2006]
- Oliphant, J. and Blockley, D. I. (1991). "Knowledge-Based System: Advisor on the Selection of Earth Retaining Structures", *Computers & Structures*, vol. 40, no. 1, 173-183.
- Orlikowski, W. J. (1993). "CASE Tools as Organisational Change: Investigating Incremental and Radical Changes in Systems Development", *MIS Quarterly*, vol. 17, no. 3, 309-340.
- Pace, S. (2004). "A grounded theory of the flow experiences of Web users", *International Journal of Human-Computer Studies*, vol. 60, no. 3, 327-363.
- Pandit, M. R. (1996). "The Creation of Theory: A Recent Application of the Grounded Theory Method", *The Qualitative Report*, vol. 2 no. 4.
Available from: <http://www.nova.edu/ssss/QR/QR2-4/pandit.html> [Accessed: 30 September 2006].
- Pries-Heje, J. (1992). "Three Barriers for Continuing use of Computer-Based Tools in Information Systems Development: a Grounded Theory Approach", *Scandinavian Journal of Information Systems*, vol. 4, 119-136.
- Rowlands, B. H. (2005). "Grounded in Practice: Using Interpretive Research to Build Theory", *The Electronic Journal of Business Research Methodology*, vol. 3, no. 1, 81-92.
- Smit, J. and Bryant, A. (2000). "Grounded Theory method in IS research: Glaser vs Strauss", *Working paper*, Leeds Metropolitan University.
- Strauss, A. Corbin, J. (1994). "Grounded theory Methodology", in N. K. Denzin and Lincoln, Y. S. (eds.) *Handbook of Qualitative research*, pp. 273-285. Thousand Oaks: Sage Publications.

- Strauss, A and Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. SAGE Publication, Inc, Newbury Park.
- Strauss, A.L. (1987). *Qualitative analysis for social scientists*. Cambridge University Press, New York.
- Urquhart, C. and Fernandez, W. (2006), "Grounded theory method: the researcher as blank slate and other myths", *Twenty Seventh International Conference on Information Systems*, Milwaukee, US.
- Urquhart, C. (2002). "Regrounding Grounded Theory – or Reinforcing Old Prejudices? A Brief Reply to Bryant", *Journal of Information Technology Theory and Application (JITTA)*, vol. 4, no.3, 43-54.
- Urquhart, C. (2001). "An Encounter with Grounded Theory: Tackling the Practical and Philosophical Issues", in E. Trauth (ed.), *Qualitative Research in Information Systems: Issues and Trends*, pp. 104-140. Idea Group Publishing.
- Urquhart, C. (1999). "Themes in early requirements gathering (The case of the analyst, the client and the student assistance scheme)", *Information Technology & People*, vol. 12, no. 1, 44-70.
- Urquhart, C. (1997). "Exploring Analyst-Client Communication: Using Grounded Theory Techniques to Investigate Interaction in Informal Requirements", in: A. S.Lee, Liebenau, J., and DeGross (ed.), *Information Systems and Qualitative Research*, pp. 149-181.
- Yoong, P. (1999). "Making sense of group support systems facilitation: a reflective practice perspective", *Information Technology & People.*, vol. 12, no. 1, 86-112.

The negotiation of standards: The case of the Open Mobile Alliance

Endre Grøtnes

University of Oslo, Norway

endregr@ifi.uio.no

Abstract. This paper looks at the negotiation that takes place within an international standardization organization, the Open Mobile Alliance. Standardization is a continuous process of negotiation, where the different actors give and take to reach an agreement. The process is very similar to that of wage negotiations or reaching a budget agreement in the parliament. In this paper I use actor-network theory to analyze the process, and to seek out factors that influence the process.

The findings are that the process of standardization is influenced by both technical and non-technical factors. The dominant factors in steering the process is the role of IPR, the internal processes of the standardization organization, time to market, and the skills of the people participating.

Keywords. Process of standardization, negotiation process, actor-network theory, Open Mobile Alliance, case study, standards.

Introduction

The current researches on standardization have used many different theories and approaches to explain the creation and adoption of standards (Fomin and Keil 2000; Fomin, Keil et al. 2003; Lyytinen and King 2006). The research has focused on economic, strategic, technical or sociological views of standardization.

Some examples of theories used are: Network externalities (Katz and Shapiro 1985), lock-in and increasing returns (Arthur 1989), actor-centered institutionalism (Schmidt and Werle 1998), externalities and governance structures (Abbott and Snidal 2001) and actor-network theory (Callon 1986; Latour 1987).

In the editorial in the MIS Quarterly's special issue on standardization (Lyytinen and King 2006) the broad range of topics and approaches to standardization are presented. They divide the contribution in the issue along the following dimensions: Type of standard investigated, level of analysis, stage in standard development and use, and unit of analysis. They also distinguish between the research approach and the theory used in the studies.

Fomin and Keil (2000) also presents different theories used to analyze standardization processes. They distinguish between economic and strategic management literature and social network theories of standardization. They also distinguish between the different stages in the standard creation/diffusion process and type of forum creating the standard.

In this paper I will look at the standards creation process. The purpose of the paper is to describe how the negotiation process unfolds within an international standards organization (SDO), and to seek out the factors that influence this process. The SDO studied in this paper is the Open Mobile Alliance.

I will use actor-network theory (ANT) to analyze the process. ANT is an approach used lately to analyze the interaction between the social and technical in standards work. The paper will also place this work in context with previous work on ANT and standards.

The rest of the paper is structured as follows. In the next chapter I introduce the basic concepts of ANT followed by a chapter that analyze what aspects of standardization ANT has been used to look at, and place this paper within that context. Then the case of the Open Mobile Alliance is presented. The paper follows up with a discussion of the negotiation process using ANT as a frame of reference. Finally I draw some conclusions.

Actor network Theory (ANT)

ANT has its roots at the *École des Mines* in Paris and was created in the mid 80's (Callon 1986; Law, Callon et al. 1986; Latour 1987). It grew out of the social studies of technology. Contrary to its name, ANT is not a stable theory, it is more a way of thinking or a way to view and analyze the world (Walsham 1997; Callon 1999; Latour 1999; Law 1999). ANT has changed over time. To view the changes the reader can look at two of Latours books, "Science in action" (Latour 1987) and "Reassembling the social" (Latour 2005) and see the difference.

ANT is concerned with how technologies come to be and looks at the interaction of heterogeneous actors in creating knowledge or technical artifacts.

ANT is more about the study of science in the making than the study of ready made science (Latour 1987). ANT does not a priori distinguish between human and non-human influence in creating knowledge, but treat the influence of all actors the same. They are all part of the same network. In ANT terms this is known as an actor-network. An actor-network consists of, and links together, both human and non-human actors.

ANT tries to diminish the agency/structure divide often found in social science (Latour 1999). ANT can be used both to describe the macro elements and the micro elements included in an actor-network. ANT is primarily about describing the construction of science and technology, but with ANT the explanation comes from the description. As (Latour 1991) said *“The explanation emerges once the description is saturated”*.

Even though ANT is not a theory, the users of ANT have created a vocabulary to describe the processes they are studying. The vocabulary of ANT is not static, and it has changed over time. The rest of the chapter will present a snapshot of the ANT vocabulary.

Actor (or actant):

An actor can be anything. Who or what is an actor is not decided up front in ANT. An actor can be people, technological artifacts, standards, organizations, procedures and other things. An actor is anything that acts (have agency on), connects to, interact with or have some form of relationship with other actors. An actor is not an actor before it comes in connection with other actors. Something in isolation is not an actor. Actors define one another in interaction (Callon 1991).

Actor-network:

An actor-network is a heterogeneous network of aligned interests that can consist of different actors (Walsham 1997). An actor-network can consist of both macro and micro elements. It describes how these heterogenous elements are linked together and how they act on each other.

Inscription:

The notion of inscription is to inscribe properties into another actor so they act on behalf of the inscriber. The inscription has the intention of making other actors act in a special way, believe a certain fact or use a specific method. Inscriptions are used to strengthen an actor-network, to make other actors behave in accordance to the actor-network that is behind the inscription.

A paradigm example on inscription is given by Latour's (1991) hotel key story. Here the manager of the hotel tries a different set of inscriptions from oral notice, to written notice, to physical by making the weight of the key knob larger and heavier, to influence the behaviour of the customers so they leave the key at the reception when they leave the hotel.

In the IS field the notion of inscription often refers to the way technical artefacts embody patterns of use (Monteiro 2000).

Translation, enrolment and alignment:

According to ANT stability and social order are continually negotiated as a social process of aligning interests. The alignment of interests takes place through a process called translation (Callon 1991).

When new actors are taken into the actor-network their interest are transformed, translated, so to fit the interests of the actor network. They are enrolled into the actor-network. An alignment is taken place when the interests of different actors converge to the same actor-network. When you are enrolled you take your place and role in the actor-network (Law, Callon et al. 1986). Translation can change over time. Sometimes they are a product of compromises and mutual adjustment negotiated through a series of iteration.

Translation can be divided into four stages (Callon 1986):

- Problematization – How to stage the problem and making oneself an obligatory passage point in the process.
- Interesement – how to get the interest of others.
- Enrolment – How to define and coordinate the role of the actors.
- Mobilization – Getting enough allies into the network.

Convergence and irreversibility:

Irreversibility occurs when it is impossible to go back to a point where a translation was only one amongst others and that translation shapes and determines subsequent translations.

“Convergence measures the extent to which the process of translation and its circulation of intermediaries lead to agreement.” (Callon 1991).

ANT and standardisation

As mentioned in the introduction of the paper the research on standards and standardization processes can focus on different aspect. What aspects have been investigated in the ANT research on standardization, and what parts of ANT has been used? That is the focus of this chapter.

The different aspects I will look for in the current research are:

- The *scope* of the standard (Is the intended use of the standard local, nationwide or global?)
- The *stage* in the development process of the standard (Is it the creation, choice or the deployment of a standard the research are looking at?)
- *Type of standard* (Is it a compatibility, minimum requirements or quality/best practice standard)

- For compatibility standards one has the *type of interoperability* sought. (Is it technical, semantically or organizational interoperability?)

The first IS papers of ANT in conjunction with standardization were published a decade ago (Hanseth, Monteiro et al. 1996; Hanseth and Monteiro 1997). These first papers on ANT and standards were closely related to the standardization of information infrastructures. Later works on Information Infrastructures (II) defines standards as one of the key components of an II (Hanseth 2000). The research on ANT and standards must to a large extent also be viewed as research on ANT and II and vice versa.

Hanseth et al. (1996) investigate the tension between standardization and flexibility in the development of an II. They discuss and compare two technologies as bases for the development of an II and gives illustration and some theoretical analysis of certain aspects of II using terms from ANT. In their paper they say that “*Standards are absolutely necessary for the II to exist*”, hence the close relationship between standards and II. The cases they use to illustrate their work are OSI and the Internet and their standardization processes. They argue that IIs becomes irreversible and resistant to change when they grow large. They use terms like actor-network, irreversibility and alignment from ANT. The paper states that “*Standardization basically corresponds to aligning or normalizing an actor-network*” and “*... notions of alignment and irreversibility capture a necessary aspect of standardization of II*”. The focus is on technical interoperability standards and how deployment of common standards can help in creating an II.

In their subsequent work Hanseth and Monteiro (1997) introduces the ANT concept of inscription. They discuss how behavior is inscribed into the development of an II and identify by whom, where and how inscriptions are made. The case they use is the standardization of a health II in Norway. They argue that standardization of IIs can be conceptualized as actor-networks and standards are means to stabilize large actor-networks. They also argue that the term inscription may help in dealing with the complexity of IIs and develop more appropriate standards. The focus is mostly on semantically interoperability standards with the prerequisite of technical interoperability standards. The stage is the development and deployment stage of the standard and for the case the scope is local/national. They also use ANT terms like inscription, translation and enrolment, but with a focus on inscription.

ANT and concepts of inscription, translation, obligatory passage point, closure, alignment, irreversibility and actor networks have also been used in recent case studies (Hanseth and Braa 2001; Braa, Hanseth et al. 2005; Chan, Lee et al. 2005; Tilson and Lyytinen 2005; Yoo, Lyytinen et al. 2005; Hanseth, Jacucci et al. 2006). The focus of these studies have been on the development and deployment of mobile services and standards in Korea (Yoo, Lyytinen et al.

2005), the choice of a mobile security standard (Chan, Lee et al. 2005), flexible standards in the development of health IIs in developing countries (Braa, Hanseth et al. 2005), the development and deployment of an electronic patient record (Hanseth, Jacucci et al. 2006), standardizing a corporate IT infrastructure (Hanseth and Braa 2001), changes in the US wireless standardization environment (Tilson and Lyytinen 2005).

Hanseth and Braa (2001) look at the definition (choice) and implementation (deployment) of standards for a corporate II. In the paper they argue that standards are not universal, they are linked and integrated with local systems. Standards get a local character when they are implemented and used. In this case the standards are permanently changing, they show how the stabilizing faze of the actor-network never ends, and argue that this is because the process of standardisation creates disorder to the domain it is supposed to create order within. The stage of the standard process is the choice and deployment stage, and the type of standards is interoperability standards. The scope of the standards is local.

Chan et al (2005) uses ANT to describe the struggle over a wireless security standard between China and the US. ANT is here employed to understand the dynamics of international competition surrounding international standards setting. The case describes how China develops its own wireless security protocols and how China tries to make the protocol an obligatory passage point by mandating the use of this protocol in its home marked instead of the protocol used internationally. The paper uses the ANT terms of translation, including the stages of problematization, interestment and enrolment, to analyse the actions of the actors. The case is about the choice of a standard and the scope is national/international. The type of standard is a technical compatibility standard.

Braa et al (2005) addresses the issue of strategies for developing IIs, and how standards influence the development. They identify complexity as the main source of challenge. They use ANT to illustrate the dynamics that unfold when independent actors try to align different but intersecting actor-networks. The focus is mainly on semantically interoperability standards. They argue that in these settings there is a need for flexible standards that can balance the tension between the central and local needs. The standards are local/national in scope.

Yoo et al (2005) use ANT in their case study of the role of standards in the diffusion of mobile broadband services in Korea. They study the role of standards in aligning the interest of different actors. They particularly look at how standards enable specific configurations of actor networks. To analyse the changes in the actor network, they use a framework consisting of three types of actor networks with standards in the middle connecting the different actor networks. They use ANT to show how actor networks are configured in different settings and at different times. The focus of the study is on actor networks and how they are configured. The stage in the standardisation process the study looks at is mainly

the deployment stage, and a little on the development stage, and the type of standards are compatibility standards. For the case the scope is national and later international standards.

Tilson and Lyytinen (2005) use ANT to describe the changes in the existing actor-network in the US wireless industry in developing and adopting standards. The study looks at the on-going reconfiguration of industry actor networks. They use the same framework as Yoo et al (2005) in their analysis. In their paper they argue that actor networks centred around standards may change fundamentally with the introduction of a new standard. To analyze the changes in the actor networks they use three different stages in the translation process; Problematization, interessement and enrolment. They argue that a common rationale for participating in standardization is to prevent other actors obtaining control of an obligatory passage point. The study looks at mainly the deployment stage, and a little on the development stage, and the type of standards involved are compatibility standards. The scope is national and industry standards.

Hanseth et.al (2006) uses ANT together with theories on reflexivity to describe the complex process of agreeing on standards for an electronic patient record system. They see the standardization attempt as a process of alignment. The case is local, touches all stages of the standard process, the intended use of the standard is national and the type of standard is a semantically interoperability standard.

To summarize we see that in IS research on standardization ANT has primarily been used to investigate the choice and deployment stage of the standard setting process. The cases are mostly local/national, and the types of standards vary between technical and semantically interoperability standards. The scope of the standards is local, national and international. Most of the ANT terminology is used, but the focus is on translation of interests, aligning of actor-networks and using ANT terminology as a part of the narrative of the cases. None of the studies have had a focus on the internal works of SDOs.

The Open Mobile Alliance (OMA)

This case description is based on participation observation in OMA over a 6-8 months period, talks with OMA participants and other industry actors and having access to the OMA portal. The OMA portal includes its document archive. The archive is unique and documents every step of every OMA specification.

Only members have access to the OMA meetings and the OMA portal. The participation in OMA meetings and access to the OMA portal was secured when a large international operator let me participate as a part of their delegation. This was approved by the OMA organisation. It was open that I was there as a researcher. OMA has a policy of no pictures or voice recording so no recordings

where made from my talks with the members and staff of OMA. I therefore denote my conversations with the participants as talks, rather than interviews.

The organisation

The Open Mobile Alliance (OMA) is a consortium with a goal of developing standards for mobile telecommunication services enablers. OMA was formed in June 2002 by the merger of WAP forum and the Open Mobile Architecture Initiative, and is today the largest standardisation consortia in the mobile industry domain. The total number of members has passed 400 as of November 2006. According to the OMA staff, approximately 1/3 of the members are from Europe, 1/3 from the US while the last 1/3 comes from Asia and Australia. Since its creation 6 more organisations has been integrated into OMA.

The OMA members span the whole mobile industry value chain including operators, vendors and content providers. This is also evident in the OMA “Memorandum and article of association” (OMA 2005) where they distinguish between four categories of companies: Operators, wireless vendors, IT/application/software vendors and content/finance/others.

OMA also has four types of membership levels: Sponsors, full, associate and supporter. Each level has its own member benefits, but only sponsor and full members can be represented in the board of directors or be elected as chairs or vice-chairs for the different work groups in OMA.

OMA is a public company registered in the UK. It is a non-profit association chartered by members of the mobile industry. As a public company OMA must have a board and a yearly general assembly. The board of directors governs the work of OMA. OMA had in November 2006 40 board members. All sponsor level members automatically have 1 board member. Full member level companies can have their representatives elected to the board of directors. The two other member categories, associate and supporters, can not be elected to the board of directors.

The board work is performed by the board committees while the technical work is entirely delegated to the technical plenary.

The goals and principles of OMA

The goal of the OMA is to create service enablers and publish enabler releases. According to OMA an enabler is “A *technology intended for use in the development, deployment or operation of a Service; defined in a specification, or group of specifications, published as a package by OMA.*” and an enabler release is defined as “*Collection of specifications that combined together form an enabler for a service area, e.g. a download enabler, a browsing enabler, a messaging enabler, a location enabler, etc.*”. (OMA 2006)

The attempt by OMA is to create sets of specifications that taken together make it possible for an operator to implement a new service, for vendors to provide the necessary technical equipment and for the content provider to provide the needed content.

According to staff and members OMA has a tacit understanding with the formal standardising organisation 3GPP that OMA should focus on the application and service level and 3GPP should focus on the transport and core technical level of the third generation (3G) mobile infrastructure.

The specification work in OMA is based on four key principles:

1. Products and services should be based on open, global standards, protocols and interfaces and not be locked to proprietary technologies.
2. The applications layer should be bearer agnostic (examples: GSM, CDMA, UMTS).
3. Architecture frameworks and service enablers are independent of operating systems.
4. Applications and platforms should be interoperable, providing seamless geographic and inter-generational roaming.

The specification process in OMA shall ensure service enablers that should work across devices, service providers, operators, networks, and dispersant geographies.

The Work process of OMA

The technical plenary and work groups

The OMA technical plenary (TP) is responsible for running specifications activities of OMA. This includes the drafting of new work items, approval of new work items, approval of the charter of new work groups, changing of the charter of existing work groups, approving requirement documents, approving architecture documents, approving technical specifications and in general oversee the technical specification activities and resolve technical issues within the OMA.

The technical work in OMA is performed in working groups (WG). WGs report to the TP and are chartered to produce work based on work items. Today OMA has 17 WGs. The TP also has two committees overseeing “Operation and processes” and “Release planning and management”. The first committee has the responsibility of the OMA process and how work is performed within OMA, while the latter has the responsibility of the planning of the release and testing of

the OMA specifications. See the organisational chart for an overview of the working groups.

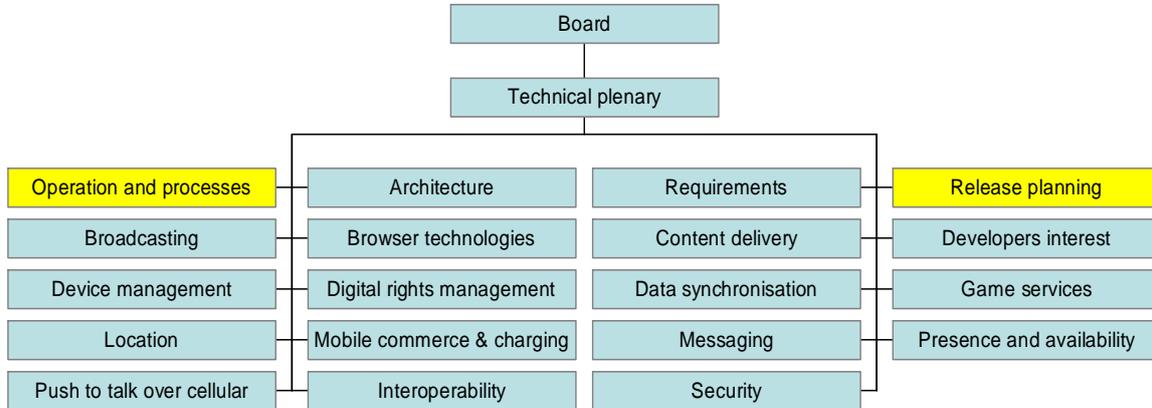


Figure 1- The OMA organization chart

The TP coordinates all activities of the WGs and committees and ensures proper process. The TP ensure that the WGs address market requirements by identifying end users requirements in the form of use cases and by defining requirements and specifications that enable interoperable services.

The way OMA is organized today is not based on the current needs of the organization, but due to historical facts. OMA is a merger of many organizations. OMA is currently looking at new ways of organizing its work groups. As one of the members expressed it *“the structure we have now is not logical and is partly due to legacy from former affiliates”*.

The process documents

The OMA work process is detailed and well documented. The work process covers things from how documents should be written to how interoperability between finished products should be tested. Compared to the processes documents of organisations like IETF (RFC-2026 1996) and W3C (W3C 2005) the work processes in OMA is specified in more detail, especially the conduct of the face-to-face meetings and how to request changes to specifications and work in progress.

OMA has three primary process documents. The “OMA organization and process document” (OMA 2006c) specifies the processes of the technical plenary of OMA, including work activities, document procedures, meeting procedures and organisational structure. The “OMA work programme and release handling process” (OMA 2006b) specifies the work program and release handling process that is used in OMA. The document can be viewed as a project management handbook for following up OMA specifications. The “OMA interoperability

policy and process” (OMA 2005b) establishes procedures for both verification and quality assurance of the OMA enabler release specifications and interoperability testing of implementations.

Discussion

This chapter will discuss the process of negotiating standards in OMA and the factors influencing this process.

All international standardization organizations (SDOs) consist of people, participating organizations, rules and regulation of the SDO, economy, and existing and new technology. Together they make up a heterogeneous network, an actor-network. We can say that OMA is an actor-network consisting of heterogeneous elements. So what is the common element in this actor-network? According to the participants in OMA they have a common goal of creating new mobile services. Creating new mobile services is the common element that is the essence of the OMA actor-network.

To guide the discussion I will divide it into the following parts:

- The OMA standards creation process,
- The OMA organization and the surroundings of OMA.
- The people and organizations participating in OMA.
- Economy.
- Technology.

Negotiation in the different stages of the process

The creation of an OMA enabler release goes through different stages/phases. First you have the creation and approval of a new work item (WI). Then you have the requirement phase where usage scenarios are gathered and negotiated and the requirements documents (RD) is made. After this you have the architecture phase where the functional elements of the enabler release are negotiated and an architecture document (AD) created. Only after the RD and AD are created the technical specification (TS) phase starts. In this phase the TS are negotiated. Together the RD, AD and TS make up a candidate release. At this point the candidate release must be approved by the technical plenary and the board of directors. This is the end point for the creation of standards in organizations like CEN and OSI, but for an OMA standard to become an enabler release it must go through 30 days of public review and interoperability testing. Figure 2 shows the different stages in the OMA standard making process. In each of these stages there are negotiations going on.



Figure 2 – The different stages of the OMA standard creation process.

The creation of a new WI is based on the members backing it. At least four members must stand behind the creation of a new WI. In this stage the initiator must get the attention of the other actors. In ANT terms you must create *interessement*. This is the start of the creation of an actor-network within the OMA actor-network. Getting the approval of a new WI, means you have succeeded in the *problematization* and *interessement* stages of the translation of the interest of the other actors.

In the requirement phase the operators are the dominant actors. They are closest to the end users needs, and take the leading role in defining user requirements. The vendors that should make technology from the finished standard are also participating. The process of enrolment and mobilization has started. This process is strengthened through the next phases. More people are enrolled and mobilized in the architectural and specification phases. With the approval of the standard as a candidate enabler there is a temporarily closure of the process. So far the negotiation has been held within the OMA community, its members and its liaisons partners. At this stage there is a break. External actors have to be mobilized and enrolled, and their interests have to be translated into the actor-network. The testing only involves the vendors with a product and the OMA staff. The decision to fail or accept a product in the interoperability testing is entirely up to them. If a product fails its interoperability test, it is not known to the rest of the OMA community. Only positive tests are published on the OMA product pages. Final closure is due to enough products having passed their interoperability tests. Final closure is not decided by all the actors in the actor-network something that leads to frustration among some actors.

The organization and the surroundings

OMA is a consensus driven organization. This is a tradition from the previous standardization activities in the telecommunication realm. All WGs seek consensus on decisions. Votes are possible when consensus is not achieved, but should only be used as an exception when it is obviously that the group can not reach consensus. The process documents of OMA say votes, but the actual guiding principle is consensus. The wish for consensus and a common goal for the participants guide the creation of standards in OMA.

Every thing that should be discussed in a meeting should be put forward in a document and be present in the agenda. The interests of the actors are inscribed into documents. All discussions are based on the documents available. The documents can be more or less detailed. Every new item in a specification, every change to a specification should be put forward in a document. The documents become a part of the actor-network.

How each meeting should be conducted and how documents should be created is well documented in OMA. Even with this basis there are differences in how the

actual meetings proceed. There are different micro procedures. As one member put it:

“I have come across two main differing styles in groups. One is the very document oriented one where the documents themselves are debated and some determination made, e.g. agreeing after perhaps some iteration or not agreeing. The other is where a general concept for a feature is introduced and a general discussion tries to find the common ground. Then a formal input document is produced which reaches agreement quickly because the general direction is well established and understood by all parties.”

This kind of up front consensus building before an input document is written is common in OMA. The operators group together to reach a common ground, and so do the vendors. The operators are a little more formal since they have interest groups like GSM association, CDMA development group and The Open Mobile Terminal Platform that directly sends input to OMA. The other groups do not have this formalism. Other SDOs also send documents to OMA to express their opinion. OMA have established liaisons with many of them. OMA takes these inputs into the standards creation process. This is a form of lobbying. Small actor-networks are working inside the larger actor-network.

So in OMA documents are important actors. The views of the different actors are inscribed into documents. The documents act as spokespersons. The documents are negotiated, their intents are translated and the result is an alignment of interests that are inscribed into a new document. The network is stabilized and an agreement is reached. In ANT terms an actor-network is stabilized when the interest of others is translated and aligned with the interests of the actor-network. The actor-network is expanded and an agreement is reached. In OMA the process of translating interest to reach agreement does not necessarily mean an alignment of interests. The negotiation process in OMA is closer to the processes found in wage negotiation and the processes used in creating a national budget in the parliament. Here agreements are also reached but the different parties still have different views and wishes.

The OMA process, the conduct of the meetings and liaisons with other organizations are factors that influence the development of standards within OMA.

People

Many of the participants in OMA are also participating in other SDOs. They are people with skills and knowledge of the business. For the companies the standards that are made in OMA are viewed as strategic important, and they want to use their best people on it. Since OMA is producing anticipatory standards, it becomes necessary with technical knowledge as well as negotiating skills for the participants. Language is also a factor in this.

The language of OMA is English. Not all of the actors are fluent in English. This gives the native English speaker an advantage. Non native English speakers

sometimes have difficulties in articulating their views in a precise and timely manner. This is slowing down the process and other participants tend to ignore their views to speed up the process. Language is a part of the actor-network.

The skills of the individual participants play a role in the creation of standards in OMA. This includes negotiation and language skills, as well as technical skill.

Economy

Creating standards have in OMA become more of a research effort than a choice between existing standards in the market. The participating companies are often pursuing their own technical development in house in parallel with the development of the standard within OMA. It is a race for getting solutions out as fast as possible after the standard has been agreed. **Time to market is a factor in the OMA standard process.** The vendors participate in the process so their products can be available a short time after the standard is approved. It takes time to set up a production line for a new product, so this must be done in parallel with the development of the standards. As one participant said; *“If we should wait until an OMA standard was approved to set up a production line, we would lag our competitors by 8-12 months to get a product on the market.”*

The companies are aligning their production lines with the OMA process, and become part of the actor-network.

Technology

OMA is in the business of creating technical specifications. Technology is a factor, but not necessarily a determinant factor, and not necessarily in the way you should think.

One of tenets of OMA is that the specification should be bearer agnostics. This means that the specification should be made neutral and should not be designed to fit just one network. OMA is creating anticipatory standards. This is different from the situation where a standard organisation, or others, faces the choice between different existing standards and technologies. The latter is often the focus of the economic research on standards (David and Greenstein 1990; Stango 2004). The role of the existing technology is then downplayed. The installed base is no longer the dominant factor. OMA creates new technology that should run on any existing infrastructure. The inscription from the existing technology on the new standard is weak. So does technology have an influence? The answer is definitely yes. It just comes under the name of intellectual property rights (IPR).

The most influential issue guiding the development of standards within OMA is the issue of essential IPR. Essential IPR means that a technology can not be implemented without the use of this IPR. IPR have been the focus of previous standardization of mobile technology (Bekkers, Verspagen et al. 2002), and IPR

makes out the backbone of many companies (Goodman and Myers 2005). IPR becomes a part of the actor-network.

Every meeting in OMA starts with a call for the members to declare if they have essential IPR. Companies that have essential IPR are supposed to declare and licence it. As one of the staff members said: *“If you don’t want to licence, you ought not to be in OMA”*.

When standards are created within OMA they use existing technology and standards as building blocks in the creation of these new standards. The new standard have not any IPR attached to it upfront, but the building blocks of the standard can have IPR attached to them, or IPR could be issued on them during the process. Sometimes a company will fill out an IPR claim shortly after a new technology has been part of a standard, because of the technical development they have done as part of the standard process.

The only way a company can become an obligatory passage point in the process of creating standards within OMA is through enforcement of its IPR. The licensing of IPR is regulated in OMA (OMA 2004; OMA 2005; OMA 2006d), so a company can not deny to license its IPR, but the negotiation of the terms associated with the use of the IPR makes it an obligatory passage point.

Getting “your” technology, and thereby your IPR, into a standard is the goal of many companies in OMA. As one participant said *“Today standardisation is all about IPR. Some companies have as much as 30% of their revenue from IPR licensing”*. Much of the negotiation of standards in OMA is a negotiation about IPR and licensing. **IPR is maybe the most influential factor in the creation of standards in OMA.** This is consistent with other research on the importance of IPR for the development of standards (Bekkers, Verspagen et al. 2002; Lee and Oh 2006; Jho 2007).

Conclusion

This case uses ANT to describe the creation of standards. From the analyses in this paper it is clear that ANT has not been used to describe the processes of standards within a SDO, so this paper is on new ground.

The standardization process in OMA is a continuous process of negotiating. Different interests are translated, but it is usually not about aligning interest but reaching agreement and closure. Technology plays a role in the process, but organizational, economic and personal factors are also important. The role of the technology is not necessarily to find the best technical solution but to find a solution that everybody can agree on. IPR is the most influential technical consideration for the participants in agreeing on a standard.

The non-technical factors that influence the standard creation process in OMA are: The OMA process, time to market, and the language and negotiation skills of the participants.

The findings here may be special for the mobile industry and the telecommunication sector. More research is needed on the processes and the inner workings of SDOs to see if these factors are evident in other sectors and organizations as well.

References

- Abbott, K. W. and D. Snidal (2001). "International standards and international governance." Journal of European public Policy **8:3**(Special issue): 345-370.
- Arthur, W. B. (1989). "Competing technologies, increasing returns, and lock-in by historical events." The economic journal **99**(394): 116-131.
- Bekkers, R., B. Verspagen, et al. (2002). "Intellectual property rights and standardization: the case of GSM." Telecommunications Policy **26**(3-4): 171-188.
- Braa, J., O. Hanseth, et al. (2005). Flexible standards. Proceedings of SIIT 2005, IEEE.
- Callon, M. (1986). Some elements of a sociology of translation; domestication of the scallops and the fishermen of St Brieuc Bay. Power, Action and Belief. A New Sociology of Knowledge? J. Law. London, Routledge: 196-223.
- Callon, M. (1991). Techno-economic networks and irreveribility. A sociology of monsters. J. Law. London, Routledge.
- Callon, M. (1999). Actor-network theory - the market test. Actor Network Theory and after. J. Law and J. Hassard. Oxford, Blackwell publishing.
- Chan, S., H. Lee, et al. (2005). An international mobile security standard dispute: from the actor-network perspective. IFIP TC8 WG 8.2 International working conference, Cleveland, Ohio, USA, Springer.
- David, P. A. and S. Greenstein (1990). "The economics of compatibility standards: An introduction to recent research." Economic of innovation and new technology **1**: 3-41.
- Fomin, V. and T. Keil (2000). Standardization: Bridging the gap between economic and social theory. Proceedings of the 21st international conference on information systems.
- Fomin, V., T. Keil, et al. (2003). "Theorizing about standardization: Integrating fragments of process theory in light of telecommunication wars." Sprouts: Working papers on information environments systems and organizations **3**(1): 29-60.
- Goodman, D. J. and R. A. Myers (2005). 3G cellular standards and patents. 2005 International conference on wireless networks, communications and mobile computing, IEEE.
- Hanseth, O. (2000). The economics of standards. From control to drift. C. U. Ciborra, Oxford university press.
- Hanseth, O. and K. Braa (2001). "Hunting for the treasure at the end of the rainbow: Standardizing corporate IT infrastructure." Computer Supported Cooperative Work **10**: 261-192.
- Hanseth, O., E. Jacucci, et al. (2006). "Reflexive standardization: Side effects and complexity in standard making." MIS Quarterly **30**(Special issue): 563-581.
- Hanseth, O. and E. Monteiro (1997). "Inscribing behaviour in information infrastructures standards." Journal of accounting, management and information technology **7**(4): 183-211.
- Hanseth, O., E. Monteiro, et al. (1996). "Developing information Infrastructures: The tension between standardisation and flexibility." Science, Technology & Human values **21**(4): 407-426.
- Jho, W. (2007). "Global political economy of technology standardization: A case of the Korean mobile telecommunication market." Telecommunication Policy **31**: 124-138.
- Katz, M. L. and C. Shapiro (1985). "Network externalities, Competition and Compatibility." The American Economic Review **75**(3): 424-440.

- Latour, B. (1987). Science in action. Cambridge, Massachusetts, Harvard university press.
- Latour, B. (1991). Technology is society made durable. A sociology of monsters. J. Law. London, Routledge.
- Latour, B. (1999). On recalling ANT. Actor Network Theory and after. J. Law and J. Hassard. Oxford, Blackwell publishing.
- Latour, B. (2005). Reassembling the social: An introduction to actor-Network Theory, Oxford University Press.
- Law, J. (1999). After ANT: complexity, naming and topology. Actor Network Theory and after. J. Law and J. Hassard. Oxford, Blackwell publishing.
- Law, J., M. Callon, et al. (1986). Mapping the dynamics of science and technology, The Macmillan press ltd.
- Lee, H. and S. Oh (2006). "A standards war waged by a developing country: Understanding international standard setting from the actor-network perspective." Journal of strategic Information Systems **15**: 177-195.
- Lyytinen, K. and J. L. King (2006). "Standard making: A critical research frontier for information system research." MIS Quarterly **20**(Special Issue): 405-411.
- Monteiro, E. (2000). Actor-Network theory and Information Infrastructure. From control to drift. C. Ciborra, Oxford university press.
- OMA (2004). Open Mobile alliance IPR procedural guidelines, Open Mobile Alliance.
- OMA (2005). The Company Acts 1985 to 1989 – Company Limited by Guarantee – Memorandum of association of Open Mobile Alliance ltd, adopted by special resolution passed on 18 October 2005 Open Mobile Alliance.
- OMA (2005b). OMA Interoperability Policy and Process. Approved Version 1.3 – 12 Jul 2005 Open Mobile Alliance.
- OMA (2006). OMA dictionary – “OMA-ORG-Dictionary-V2_4-20060725-A” - Approved Version 2.4 – 25 July 2006, Open Mobile Alliance.
- OMA (2006b). OMA Work Programme and Release handling process. Approved Version 1.3 – 23 May 2006, Open Mobile Alliance.
- OMA (2006c). OMA Organization and Process. Approved Version 1.3 – 29 May 2006, Open Mobile Alliance.
- OMA (2006d). Open Mobile Alliance- application form.
- RFC-2026 (1996). The Internet Standards Process -- Revision 3 (RFC 2026). RFC. IETF.
- Schmidt, S. K. and R. Werle (1998). Coordinating technology: Studies in the international standardization of telecommunications, MIT press.
- Stango, V. (2004). "The economics of standard wars." Review of network economics **3**(1): 1-19.
- Tilson, D. and K. Lyytinen (2005). "Making Broadband Wireless Services: An actor-network study of the US wireless industry standard adoption." Sprouts: Working Papers on Information Environments, Systems and Organizations **5**(3): 137-154.
- W3C (2005). World Wide Web Consortium Process Document - 14 October 2005.
- Walsham, G. (1997). Actor-network Theory and IS research: Current status and future prospects. Proceedings of the IFIF TC8 WG 8.2 International conference on information systems and qualitative research, Philadelphia, Chapman & Hall.
- Yoo, Y., K. Lyytinen, et al. (2005). "The role of standards in innovation and diffusion of broadband mobile services: The case of South Korea." Journal of strategic Information Systems **14**: 323-353.

Story, Narrative and Storyteller in IS Research

Thomas Persson Slumpi

Department of Information Technology and Media

Mid Sweden University, Östersund

thomas.persson@miun.se

Abstract. The use of stories and narratives in the design process is something that been around for a while, both in Information systems (IS) -research and -practice. However, the impact this use have had on the IS-field is not clear. In this paper this impact is investigated by a scan of articles in journals that can be viewed as good representatives for IS mainstream research, and to a less extent representatives for more innovative approaches. It is also investigated how stories and narratives can inform the design process, and if and how IS researchers have addressed information technological artefacts (ITA) as storytellers. The results of this scan is categorised into four categories, form, object, method and theory, which mirrors how the concepts is used as well as how the concepts can inform the design process. In this scan it also becomes clear that the narrator or the storyteller nor the activities of narrating or storytelling is in focus in any of the articles. It is argued in this paper that viewing ITAs as storytellers might have implication for design and can complement the change focus often present in design projects with a storytelling focus.

Keywords. Narrative, Story, Storyteller, Information systems, Design

1. Introduction

The use of stories and narratives in the design process is something that been around for a while. Ericson argued in 1996 for the relevance of stories in interaction design, both as a means for capturing problems as well as a way of communicating with the target organization (Ericson, 1996). Ten years later this is echoed by Parrish (2006) when he argues that stories can be used in several of the phases in instructional design. Other researchers have also approached the design process from a narrative or story approach.

For example Isomursu, Isomursu and Still (2004) argue that stories can be used to involve target groups that otherwise can be hard to involve in the design process and Garcia, Carretti, Ferraz and Bentes (2002) present a storytelling tool to help designers share their visions with other designers. The design process, described by Simon (1996) as changing existing situations into preferred ones; by Löwgren and Stolterman (1998) as creating products with the aim to change or support change of peoples actions, and something different from solving a problem in the formal logic way (Löwgren and Stolterman, 2004); or by Ericson, (ibid) as well as Garcia et al (ibid) as a collaborative effort between designers or between designers and the target organization, can clearly be informed by stories and narratives in different ways.

The use of stories and narratives in the design process, at least as described by the above researchers, is closely related to human activity. It is humans who use stories and narratives to capture problems, for communication and collaborative purposes, and to involve different groups in the design process. However, in a paper in Library and Information Science Research from 2005 Gazan adds another dimension to who the teller of stories and narratives in the design process can be. In the conclusions of his paper Gazan states:

Framing future information systems in light of the stories they tell about the people and the content represented within can inform design and better match how designers and users approach the system in practice (Gazan, 2005, p 359)

In this quote Gazan does not only argue for stories and storytelling as a way of approaching design issues. It is also something that no longer is the privilege of humans only. As the author of this paper interprets Gazan, storytelling is something that artifacts also can do.

This introduction concludes in one main research question and two sub-questions. First of all the author of this paper argue that it is not clear how the story/narrative approach has influenced mainstream research within the IS field. Hence, the main research question for this paper is: *In what ways have mainstream research within the IS field addressed narratives and stories?* The author of this paper is convinced that the story/narrative approach has not passed the IS field by without a trace, but what impact has it had so far. The first sub-question is related to the impact so far but also the possible impact it can have on design initiatives: *In what ways can the use of stories/narratives be related to the design process?* The second sub-question is directly related to the quote of Gazan and can be phrased as follows: *Has mainstream research in the IS field addressed the idea of information technological artefacts as storytellers, and if so how?* (Information Technological Artefacts are from here on abbreviated to ITA and includes more or less all artefacts that generate information of any kind). To find answers to these questions a review of articles in some important and distinguished journals in the IS field is conducted.

The main purpose of this paper is to investigate the impact the story/narrative approach has had on mainstream research in the IS field so far and how it has informed the design work. It is also the purpose to highlight the possibility of viewing ITAs as storytellers, hence adding a new dimension to the design practise as well as research.

2. Narratives and narrators

In this section the concepts of narrative and narrator will be explored and related to other concepts with similar meaning through the use of narrative theory mostly. However, the statement of Gazan in the introduction is also discussed by using actor-network theory (ANT).

2.1. Narrative, story and narrating

What is a narrative really? It is not all that easy to answer this question. There is not a homogenous view on what a narrative is and this can be illustrated with the forty-one questions Prince (2000) asks concerning the nature of narrative, for example is a football match on television, a theatrical play, the representation of future change, dreams, memories, and obituaries narratives? To be able to at least make the concept of narrative more comprehensible it is important to understand the relation between story and narrative. According to for example Polkinghorne (1988) there is no difference between these two concepts. Others like Genette (1980; 1988) or Prince (2003) argue that it is a difference and defines story as the totality of the narrated event or the content plane and a narrative as the discourse, oral or written, that narrates the story, the expression plane. This basically means that the story is what to be told while narrative is how it is told. This leads us to the concept of narrating. In Genette (ibid) narrating is the act of recounting of an event and Prince (ibid) defines narrating in a similar way by stating that narrating is the telling or relating of one or more events. Narrating is, short and simple, the act of creating a narrative.

With the relation between narrative, story and narrating illuminated the focus can be put on what a narrative is. On the subject of defining narratives Richardson (2000) account for four basic approaches. The first approach is that the narrative is an representation of events in a time sequence (temporal), the second is that there is a casual connection between the events in an narrative (casual), the third is that every statement of an action or event is a narrative because it implies a transition from an earlier state to a later state (minimal), and finally the fourth approach where a narrative is simply a way of reading a text, rather than a feature in a text (transactional).

Another way of defining narrative is provided by Flaudernik (2000) when she suggests that narrative text types (novels, drama, film, myths, etcetera) should be separated from non-narrative text types such as argumentative text types (scientific texts or newspapers), instructive text types (guide books or how-to-books), conversational text types (letters or contracts) and reflective text types (art criticism or philosophy). Flaudernik (ibid) argues that the non-narrative text types are part of the narrative's surface structure and supports it, but does not contribute to the narrative.

A third way of understanding narratives that shares characteristics with the other two is provided by van Peer and Chatman (2001) as quoted below:

Narratives are texts about events structured in time. They are about agents who act in the real or fictional worlds, responding to their inner drives as well as to external circumstances. Narratives

typically start with imbalances that protagonists attempt to address. Usually these attempts lead to complications, setbacks, crises, and ultimately to success or failure. (van Peer and Chatman, 2001, p 2).

These three ways of defining narrative provides a fairly good picture of what a narrative is about. For this paper it is not necessary to adopt a particular view of narratives because the purpose of this paper is to investigate how the IS field uses narratives. However, this short introduction indicates that the concept of narratives can be defined and understood in different ways.

2.2.ITAs as narrators

When it comes to the narrator, it is obvious that humans are in focus. Prince (ibid) writes that a narrator is the one who narrates and is located at the same level as the one he or she addresses. The assigning of a grammatical gender (he or she) to the narrator excludes all non-humans from this activity. This is also something that van Peer and Chatman (2001) indirectly addresses when they states that there is still not possible to generate stories with computers. Does this means that Gazan is wrong about ITAs being narrators? To extract the discussion outside narrative theory I turn to ANT for input concerning technological artifacts position in social contexts. One of the key features of ANT is the equalizing of human and non-human actors within an actor-network (Callon, 1991; Callon and Latour, 1992; Latour, 2005; Walsham, 1997). Equalizing humans and non-humans does not mean that non-humans are given intentionality or that humans are mechanized (Callon and Latour, 1992). Instead this implies that humans and non-humans are mutually constructing each other and mutually participates in the construction of the social fabric. But is it really possible that non-humans can be positioned on the same level as humans? In Latour (2005), in the section labeled *On the difficulty of being an ANT*, a few general hints concerning this is given. First of all it is important to understand what ANT is and is not about. ANT is not about positions and structures, and is about links, relations, movement, flows and changes. Hence, to become an actor one has to be part of the ongoing transitions in a certain context (network or as Latour (2005) rephrases it, work nets). An actor is one who does something (work), and by taking part in different transition processes, an actor makes a difference and leaves traces (in the net). Finally, Latour (ibid) states that one particular actor cannot be substituted by another with exactly the same result. To sum up, an actor is one who does some work, takes part in the ongoing action within a net, makes a difference, leaves traces and cannot be substituted by another actor with the same result.

After this detour into ANT we can get back to the question in focus: Can ITAs be narrators? Theoretically this is possible. In ANT humans and non-humans are viewed as equal participants and ascribed the same possibility to take action in a work net. With that follows that if a human's work in a net is viewed as narrating then a technological artifact could do the same thing. Further, if recounting of any event, no matter what, is regarded a narrative, then why should not economic reports generated from a economy system or the telling of temperature from a thermometer be a narrative? A economy system can tell narratives of happy and prosperous days of an organization, as well as tragic narratives of

recess. A thermometer, if some sort of memory is added, can tell narratives of warm periods as well as cold periods. If the technological artifacts would be replaced by human actors the narratives could be similar or completely different, but they would probably not be the same. A human can go outside and say that it is cold day, because it was rather windy that particular day, while the thermometer would tell a narrative of a rather warm day; same event different narratives. The conclusion is that it seems possible that ITAs can be viewed as narrators. But, what is IS research's view on this matter and how has narratives been used all together?

3. Method

On trying to answer the research questions for this paper a similar investigation approach to the one conducted by Adam, Howcroft and Richardson (2004) on gender in IS journals is adopted for this paper, but focusing on stories and narratives instead. The same journals as Adam et al investigated are also investigated here: *Communications of the ACM*, *European Journal of Information Systems*, *Information and Organization*, *Information Systems Journal*, *Information Systems Research*, *Information Technology and People*, *Journal of Information Technology*, *Journal of Strategic Information Systems*, *MIS Quarterly* and *Scandinavian Journal of Information Systems*. Adam et al (ibid) claim that these journals represent main stream research as well as more innovative approaches. This is true but it is probably the case that other journals also are good represents for mainstream research. But these journals are distinguished and high ranked and should give at least some indications on how the investigated concepts are used.

The electronic versions of the journals, provided by the library at Mid Sweden University, were scanned. To get a first picture of how frequent the use of the story/narrative approach occurs in the journals the scan is limited to cover abstract of the articles only. This is of course of weakness because there is a risk that interesting contributions can be omitted, which also is established in this study as we will see later on. However, scanning through all articles' body text with for example the word story in one form or another would be too time consuming and probably would render some but not radical different views and uses of the concepts than the articles with the concepts in the abstract. Focusing on the abstracts, I argue, is also focusing on what the authors find most relevant in their articles.

The scan is also limited to cover articles only, meaning that book reviews, debate contributions, interviews, etcetera are excluded. There are no restrictions concerning the time span because the aim is to give a more or less comprehensive review of the discussion concerning this perspective. Though, the time span is limited involuntarily because for some journals less issues are available than for others. The author of this paper does not see this as a big problem because the aim of this paper is not to compare different journals but to achieve a general understanding of how narratives are used in the field. However, the readers of this article are provided with the time span for each of the journals in table 1 in the result section of this paper.

The scan was divided into two sessions. In the first session, on the 14th of mars 2007, the journals *Communications of the ACM*, *European Journal of Information Systems*, *Information and Organization*, *Information Systems Journal*, *Information Systems Research*, *Information Technology and People* were scanned. In the second session, on 15th of mars 2007, the remaining journals, *Journal of Information Technology*, *Journal of Strategic Information Systems*, *MIS Quarterly* and *Scandinavian Journal of Information Systems* were scanned.

The search criteria used in this scan are narrative, narrating, narrator, story and storyteller. These five criteria were chosen for two reasons. The first reason is that, as seen above, story, narrative and narrating are central in narrative theory. However, these three words do not directly take into account the subject that performs the narrating. The objects - the event and the narrative - and the action – narrating - are included but not the subject. So, I also included narrator and storyteller into my set of search criteria. I argue that the subject is important and cannot be excluded because if there were no subject, no narratives would ever be created. One possible weakness in the above search criteria is that the plural form of story was not explicitly used as search criteria. This might have affected the amount of hits in some journals while in others the plural form of story where included automatically. For the other criteria the singular form also covered the plural form of the criterion for example narrative and narratives.

For scanning the abstract of the journals the search engines provided by each journal was used. However, in the scan of Scandinavian Journal of Information Systems there was a little problem because there was no function to scan abstracts on the website, only a full text body scan of each article was possible. Hence, for this journal a full body text scan was conducted on all the articles using the same criteria as for the others, and after that the abstract of each of the articles generated were scanned individually. In this process a weakness in the research method, as mentioned earlier in this section, was identified because four papers with possible relevant content for the study Baskerville (1996), Ovaska, Rossi and Smolander (2005), Star (2002), and Zuiderent (2002) were found that did not have any of the search criteria in the abstract (see Appendix 1 for full references). For the time being these articles is not further analyzed but they show that the method has at least one big flaw.

After that the relevant articles had been identified the analysis work began by scanning the body text for the search criteria and interpreting how each criterion was used (appendices, bibliography etcetera excluded). This was done for all articles except for five Galliers (1993), Hitchman (1997), McGrath (2002), Segars, Grover and Kettinger (1994), and Ramiller, (2001). The first four are for the time being not accessible for the author of this paper. The fifth is accessible but there is not possible to scan the body text. After the use of the search criteria were determined for each paper different categorize are constructed. The categories are created in relation to the material, meaning that there are no categories constructed before the analysis work begins. This approach is described by for example Taylor (2001) as a search for something you do not know what it looks like but you are convinced that something exists in the material. Finally each category is discussed from a design perspective.

4. The story/narrative approach in IS research

In the first scan 48 articles were identified having any of the search criteria in the abstract (see Appendix 2 for presentation of all articles identified). The hits were distributed on two criteria only: narrative (13 hits) and story (36 hits). One article had both narrative and story in the abstract (Ramiller, 2001 in Information Technology and People). Neither the activity of narrating nor narrator or storyteller were actually mentioned in any of the abstracts (see Table 1). All of the journals had either the concept of narrative or the concept of story present in at least one article. The distribution based on journals and number of articles identified is presented in table 1.

	Narrative	Narrating	Narrator	Story	Storyteller
Communication of the ACM 1958-2006	1	0	0	16	0
European journal of information systems 1997-2006	1	0	0	1	0
Information and organization 2001-2006	2	0	0	1	0
Information systems journal 1997-2006	0	0	0	3	0
Information systems research 1990-2006	1	0	0	0	0
Information technology and people 1996-2006	3	0	0	1	0
Journal of information technology 1986-2003	0	0	0	1	0
The journal of strategic information systems 1991-2006	2	0	0	5	0
MIS Quarterly 1977-2006	2	0	0	8	0
Scandinavian journal of information systems 1989-2006	1	0	0	0	0
Total	13	0	0	36	0

Table 1: Distribution of hits based on journals

The scan of the body text of each article further revealed whether the criterion where located -in the abstract only or in the body text as well- and which other criteria, if any, were present in the body text. (see Appendix 3). Some of the articles only mentioned the search criterion in the abstract for example Beusmans and Wieckert (1989), Earnest

(1989) or Leidner and Jarvenpaa (1994), while others like Agre (2003) or Danielson and Briggs (1963) mentions the search criterion several times in both abstract and body text. In several cases only one criterion were mentioned for example in Baskerville and Pries-Heje, 2001; Shang and Seddon, 2002, or Winston, 1980 while others had several of the search criteria in the body text for example Clausen, 1994; Giguette, 2006; or Kuechler and Vaishnavi, 2006. The least frequent criteria in the articles where narrating with no hits, storyteller with one hit (Clausen, 1994) and narrator with one hit (Giguette, 2006).

5. The IS approach to stories and narratives

To begin with, the rather sharp line between story (content) and narrative (expression) is nothing that could be clearly detected in the articles studied; rather the two concepts are used as more or less interchangeable. It is for example rather difficult to see the difference between

[A] *narrative of performance* (Porra, Hiersheim and Parks, 2005, p 721)

and

[A] *fascinating story of forging...* (Grover and Saeed, 2003, p 119)

An even better illustration of the interchangeable use of these two concepts is the only article that has both narrative and story in the abstract. In Ramiller (2001) the relation between story and narrative is described like this.

So goes a story current among systems practitioners. This tale of “Airline Magazine Syndrome” is analyzed here as an instance of narrative... (Ramiller, 2001, 287)

Ramiller is using the word tale as a synonym for story and then states that the story is an instance of narrative. This is interpreted by the author of this paper as the particular story presented is part of a bigger story, a narrative, which is far from the content/expression discussion. Hence, it is impossible to only use one of the concepts in the following analysis.

Continuing with the analysis of the results a few different perspectives on how IS researchers’ address and use narratives in their research and how narratives are relevant for IS design could be identified. These different perspectives are the foundation of the categories created. The first category created is one labeled **The form category**. In this category story/narrative is used as a form for presenting research or illustrating something interesting or problematic. Relating to the design process one could say that the narrative/story is the way the author “talks” about the design or design issues. For example in Denning (2005), a story is a way of presenting the research:

Locality of reference is a fundamental principle of computing with many applications. Here is its story (Denning, 2005, p 19)

Earnest (1989) uses it in a similar way when using a story to illustrate a problem:

I will illustrate one such problem with a true story (Earnest, 1989, p 173)

The second category created is labeled **The object category**. In this category the story/narrative is viewed as an object that can be addressed by for example technology, something that can be found neatly packaged, or something that can be altered. In relation

to design this means either that the story/narrative that is in focus for the design initiative or is some sort of entity that the designer can collect and use for informing the design process. In Danielson and Briggs (1963) a computer news editing program is presented. The function of this program is presented as follows:

(1) it [the program] will input automatically those stories from AP Teletypesetter tape which the editor wishes to use; (2) it will make additions and deletions in these stories according to instructions received from the editor... (Danielson and Briggs, 1963, p 487)

Another example of this category is provided by Shang and Seddon (2002) when they in their abstract write:

Based on an analysis of the features of enterprise systems, on the literature on information technology (IT) value, on data from 233 enterprise systems vendor-reported stories published on the web... (Shang and Seddon, 2002, p 271)

A final example is provided by Kuechler and Vaishnavi (2006):

[W]e designed a series of experiments that demonstrate that the explicit inclusion of goal information for activities in narrative description of problematic business processes...(Kuechler and Vaishnavi, 2006, p 961)

The third category created is labeled **The method category**. In this category story/narrative is a way of conducting research or development and design activities. Introna (1996) presents how narrative can be used in ateleological systems development:

Narrative, metaphor and myth seem to provide some indicators on how such ateleological development may be achieved (Introna, 1996, p 20)

Mansell (2005) clearly states that the design/methodology/approach of the article has some elements of narrative:

The paper combines narrative with argument and analysis (Mansell, 2005, p 21)

Roy and Lerch (1996) criticize the use of problem narratives as method in decision making:

We also show how this mental representation may be modified when a graph is used instead of a problem narrative (Roy and Larch, 1996, p 233)

The fourth category created is labeled **The theory category**. In this category story/narrative is a way of explaining events or is the point of departure for projects. For design purposes this means that the design can have its origin in the story/narrative theory or that different types of design could be explained by this theory strand. Kuechler and Vaishnavi (2006) describe how research in narrative comprehension informed the process of designing experiments:

Informed by research on information presentation, decision making, and narrative comprehension, we designed a series of experiments...(Kuechler and Vaishnavi, 2006, p 961)

Ellingsen and Monteiro (2003) understand knowledge to be embedded in for example narratives:

Given that knowledge (intensive) work takes place immersed in truly heterogeneous networks of knowledge representations (codified, narrative, embedded in routines, inscribed in artifacts)...(Ellingsen and Monteiro, 2003, p 203)

Baskerville and Pries-Heje (2001) use the story metaphor to high-light the different outcomes of different models produces when applied on the same empirical material:

Rather than develop conflicting stories, each model leads to distinctly different, but complementary, knowledge about the case setting (Baskerville and Pries-Heje, 2001, p 181)

The four comprehensive categories created show how diverse the use of narrative/story in IS mainstream research is. It comprises everything from a story/narrative being the object of change via the use story/narrative for pure presenting purposes to the use of it as a methodology or a theory.

Moving on to the question if and how IS researchers have addressed ITAs as storytellers, the absent of the concepts of storyteller as well as narrator in the abstract shows that this is nothing that IS research so far have recognized as important. However, both narrator and storyteller were mentioned in the body text of one article each. In Clausen's (1994) storyteller is positioned in the design process as follows:

[I]n this case the users are the storytellers and the designer is the listener (Clausen, 1994, p 48).

Approaching users as storytellers can obviously inform the design process. Giguette's use of narrator on the other hand, does not really inform the IS field in general nor the design process. Giguette uses narrator in an example concerning Poe's poem *The raven* and how the narrator state of mind is symbolized in the actions of the raven. It is interesting that the object (story/narrative) is more or less disconnected with its creator. Even though that in many cases it really is the creator that is or should be in focus. Because of this lack of interest for the creator of the story/narrative, it is not strange that technological artifacts have not been discussed in these terms. Even though that ANT propagates for equalizing humans and non-humans in work nets this has not been able to influence the perception of artifacts as narrators because in the IS field not even humans have been addressed in this manner to any larger extent.

It is also interesting to note that the act of creating a narrative (narrating) is not mentioned at all in any of the articles (not abstract nor body text) while the act of creating stories (storytelling) was mentioned in three articles. In Ellingsen and Monteiro (2003) storytelling is positioned on the same level as reporting, joking etcetera, simply a way of communicating. Madon (1999) positions storytelling in a similar way and describes it as an informal form of information exchange. Finally Scott and Barrett (2005) identify storytelling to be important for the work in organizations.

6. Discussion and conclusions

There are several conclusions that could be drawn from this study. First of all, in IS research the story/narrative approach has been addressed and/or used to a limited extent and in rather varies ways. It is also established that the design process can be informed in different ways by the story/narrative approach. In this article these ways are categorized as form, object, method and theory.

It is also clear that the subject creating a story or narrative is not present at all, hence ITAs have not been viewed as narrators or storytellers. However, this view is something that potentially is important because by viewing ITAs as storytellers the function of the artifact is diversified. From having a change function, which is a rather short term

function, to a narrating function, which is a function that spans over the artifacts whole life. A final conclusion is that the method used for this paper has at least one weakness that is important to address.

7. References

- Adam, A., Howcroft, D. and Richardson, H. (2004). "A decade of neglect: reflecting on gender and IS", *New Technology, Work and Employment*, vol. 19, no. 3, 222-239.
- Callon, M. (1991). "Techno-economic networks and irreversibility", in J. Law. (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination*, pp 132-157.
- Callon, M and Latour, B. (1992). "Don't Throw the Baby Out with the Bath School! A Replay to Collins and Yearly", in A. Pickering (ed.) *Science as practice and culture*, pp 343-368, The University of Chicago Press, Chicago, IL.
- Ericson, T. (1996). "Design as Storytelling", *Interactions*, vol. 3, no. 4, 30-35.
- Flaudernik, M. (2000). "Genres, Text Types, or Discourse Modes? Narrative Modalities and Generic Categorization", *Style*, vol. 34, no. 1, 274-292.
- Garcia, A. C. B., Carretti, C. E., Ferraz, I. N. and Bentes, C. (2002). "Sharing design perspectives through storytelling", *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, vol 16, 229-241.
- Gazan, R. (2005). "Imposing structures: Narrative analysis and the design of information systems", *Library and Information Science Research*, vol. 27, 346-362.
- Genette, G. (1980). *Narrative discourse: An essay in Method*. Cornell University Press, Ithaca, NY.
- Genette, G. (1988). *Narrative discourse revisited*. Cornell University Press, Ithaca, NY.
- Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press, Oxford.
- Löwgren, J. and Stolterman, E. (1998). *Design av informationsteknik – materialet utan egenskaper*. Studentlitteratur, Lund.
- Löwgren, J. and Stolterman, E. (2004). *Thoughtful interaction design: a design perspective on information technology*. The MIT Press, Cambridge, MA.
- Isomursu, M., Isomursu, P. and Still, K. (2004). "Capturing tacit knowledge from young girls", *Interacting with Computers*, vol. 16, 431-449.
- Parrish, P. (2006). "Design as Storytelling", *TechTrends*, vol. 50, no. 4, 72-82.
- Polkinghorne, D. E. (1988). *Narrative knowing and the human sciences*. State of New York Press, Albany.
E-book: <http://www.bib.miun.se> (070530)
- Prince, G. (2000). "Forty-One Questions on the Nature of Narrative", *Style*, vol. 34, no. 2, 317-318.
- Prince, G. (2003). *Dictionary of Narratology: Revised Edition*. University of Nebraska Press, Lincoln.
- Richardson, B. (2000). "Recent Concepts of Narrative and the Narratives of Narrative Theory", *Style*, vol. 34, no. 2, 168-175.
- Simon, H. (1996). *The Science of the Artificial, third edition*. The MIT Press, Cambridge, MA.
- Taylor, S. (2001). "Locating and Conducting Discourse Analytic Research", in M. Wetherell., Taylor. S. and Yates S, J.. (eds.) *Discourse as Data: A Guide for Analysis*, pp 5-48, Sage Publications Ltd, London.
- van Peer, W. and Chatman, S. (2001). "Introduction", in W. van Peer and Chatman, S. (eds.) *New perspectives on narrative perspective*, pp 1-17, State University of New York Press, Albany, NY.

Walsham, G. (1997) "Actor-Network Theory and IS Research: Current Status and Future Prospects", in A. S. Lee., Liebenau, J. and DeGross, J. I. (eds.) *Information systems and qualitative research*, pp 466-480, Chapman and Hall, New York, NY.

Appendix 1

- Baskerville, R. (1996). "Deferring Generalizability: Four Classes of Generalization in Social Enquiry", *Scandinavian Journal of Information Systems*, vol. 8, no. 2, 5-28.
- Ovaska, P., Rossi, M. and Smolander, K. (2005). "Filtering, Negotiating and Shifting in the Understanding of Information System Requirements", *Scandinavian Journal of Information Systems*, vol. 17, no. 1, 31-66.
- Star, S. L. (2002). "Infrastructure and ethnographic practice", *Scandinavian Journal of Information Systems*, vol. 14, no. 2, 107-122.
- Zuiderent, T. (2002). "Blurring the center: On the politics of ethnography", *Scandinavian Journal of Information Systems*, vol. 14, no. 2, 59-78.

Appendix 2

- Agarwal, R. and Lucas Jr, H. C. (2005). "THE INFORMATION SYSTEMS IDENTITY CRISES: FOCUSING ON HIGH-VISIBILITY AND HIGH-IMPACT RESEARCH", *MIS Quarterly*, vol. 29, no. 3, 381-398.
- Agre, P. E. (2003). "P2P and the promise of internet equality", *Communications of the ACM*, vol. 46, no. 2, 39-42.
- Baskerville, R. and Pries-Heje, J. (2001). "A multiple-theory analysis of a diffusion of information technology case", *Information Systems Journal*, vol. 11, no. 3, 181-212.
- Beusmans, J. and Wieckert, K. (1989). "Computing, research, and war: if knowledge is power, where is responsibility?", *Communications of the ACM*, vol. 32, no. 8, 939-951.
- Cats-Baril, W. L. and Jelassi, T. (1994). "The French videotext system Minitel: A successful implementation of a national information technology infrastructure", *MIS Quarterly*, vol. 18, no. 1, 1-20.
- Clausen, H. (1994). "Designing Computer Systems from a Human Perspective: The Use of Narratives", *Scandinavian Journal of Information Systems*, vol. 6, no. 2, 43-58.
- Crawford, D. (1991). "Supercomputing Policy Links Science and the "C" Word", *Communications of the ACM*, vol. 34, no. 11, 25-28.
- Danielson, W. A. and Briggs, B. (1963). "A Computer Program for Editing the News", *Communications of the ACM*, vol. 6, no. 8, 487-490.
- Denning, P. J. (2005). "The Locality Principle", *Communications of the ACM*, vol. 48, no. 7, 19-24.
- Dickson, G. W., Partridge, J-E. L. and Robinson, L. H. (1993). "Exploring Modes of Facilitative Support for GDSS Technology", *MIS Quarterly*, vol. 17, no. 2, 173-194.
- Ellingsen, G. and Monteiro, E. (2003). "Mechanisms for producing a working knowledge: Enacting, orchestrating and organizing", *Information and Organization*, vol. 13, no. 3, 203-229.
- Earnest, L. (1989). "Can computers cope with human races?" *Communications of the ACM*, vol. 32, no. 2, 173-182.
- Freeman, L. A. and Urbaczewski, A. (2005). "Why do People Hate Spyware?", *Communications of the ACM*, vol. 48, no. 8, 50-53.
- Galliers, R. D. (1993). "IT strategies: beyond competitive advantage", *The Journal of Strategic Information Systems*, vol. 2, no. 4, 283-291.
- Gigette, R. (2006). "Building Objects Out of Plato: Applying Philosophy, Symbolism, and Analogy to Software Design", *Communications of the ACM*, vol. 49, no. 10, 66-71.
- Glass, R. L. (2004). "The mystery of formal methods disuse", *Communications of the ACM*, vol. 47, no. 8, 25-28.
- Grover, V. and Saeed, K. (2003). "The telecommunication industry revisited: the changing pattern of partnerships", *Communications of the ACM*, vol. 46, no. 7, 119-125.
- Harmon, P. (1995). "Object-oriented AI: a commercial perspective", *Communications of the ACM*, vol. 38, no. 11, 80-86.
- Hitchman, S. (1997). "Using DEKAF to understand data modelling in the practitioner domain", *European Journal of Information Systems*, vol 6, no. 3, 181-189.

- Iacovou, C. L. and Dexter, A. S. (2005). "Surviving IT Project Cancellations", *Communications of the ACM*, vol. 48, no. 4, 83-86.
- Introna, L. D. (1996). "Notes on ateological information systems development", *Information Technology and People*, vol. 9, No. 4, 20-39.
- Kuechler, W. L. and Vaishnavi, V. (2006). "SO, TALK TO ME: THE EFFECT OF EXPLICIT GOALS ON THE COMPREHENSION OF BUSINESS PROCESS NARRATIVES" *MIS Quarterly*, vol. 30, no. 4, 961-995.
- Lanzara, G. F. (2000). "Between transient constructs and persistent structures: designing systems in action", *The Journal of Strategic Information Systems*, vol. 8, no. 4, 331-349.
- Leidner, D. E. and Jarvenpaa, S. L. (1994). "The use of information technology to enhance management school education: A theoretical view", *MIS Quarterly*, vol. 19, no. 3, 265-291.
- Madon, S. (1999). "International NGO:s networking, information flows and learning", *The Journal of Strategic Information Systems*, vol. 8, no. 3, 251-261.
- Madon, S., Sahay, S. and Sahay, J. (2004). "Implementing property tax reforms in Bangalore: an actor-network perspective", *Information and Organization*, vol. 14, no. 4, 269-295.
- Mansell, R. (2005). "Social informatics and the political economy of communications", *Information Technology and People*, vol. 18, no. 1, 21-25.
- Mason, R. O., Mckenny, J. L. and Copeland, D. G. (1997). "An historical method for MIS research: Steps and assumptions", *MIS Quarterly*, vol. 21, no. 3, 307-320.
- Mathis, C. and Ives, B. (1986). "Competitive Information Systems in Support of Pricing", *MIS Quarterly*, vol. 10, no. 1, 84-96.
- McBride, N. (2005). "Chaos theory as a model for interpreting information systems in organizations", *Information Systems Journal*, vol. 15, no. 3, 233-254.
- McGrath, K. (2002). "The Golden Circle: a way of arguing and acting about technology in the London Ambulance Service", *European Journal of Information Systems*, vol. 11, no. 4, 251-266.
- McKenny, J. L., Mason, R. O. and Copeland, D. G. (1997). "Bank of America: The crest and trough of technological leadership", *MIS Quarterly*, vol. 21, no. 3, 321-353.
- Mowery, D. C. (2003). "50 Years of business computing: LEO to Linux", *The Journal of Strategic Information Systems*, vol. 12, no. 4, 295-308.
- Nandhakumar, J. (1996). "Executive information system development: a case study of a manufacturing company", *Journal of Information Technology*, vol. 11, no. 3, 199-209.
- Neumann, P. G. (1995). "Reviewing the risks archives", *Communications of the ACM*, vol. 38, no. 12, 138.
- Porra, J., Hirschheim, R. and Parks, M. S. (2005). "The History of Texaco's Corporate Information Technology Function: A General Systems Theoretical Interpretation", *MIS Quarterly*, vol. 29, no. 4, 721-746.
- Porra, J., Hirschheim, R. and Parks, M. S. (2006). "Forty years of the corporate information technology function at Texaco Inc. – A history", *Information and Organization*, vol. 16, no. 1, 82-107.
- Ramiller, N. C. (2001). "Airline Magazine Syndrome: Reading a myth of mismanagement", *Information Technology and People*, vol. 14, no. 3, 287-303.
- Reich, B. H. and Kaarst-Brown, M. L. (1999). "'Seeding the Line': Understanding the Transition From IT to Non-IT Careers", *MIS Quarterly*, vol. 23, no. 3, 337-364.
- Roy, M. C. and Lerch, F. J. (1996). "Overcoming Ineffective Mental Representation in Base-rate Problems", *Information Systems Research*, vol. 7, no. 2, 233-247.
- Sarker, S. and Lee, A. S. (1999). "IT-enabled organizational transformation: a case study of BPR failure at TELECO", *The Journal of Strategic Information Systems*, vol. 8, no. 1, 83-103.

- Scott, S. V. and Barrett, M. I. (2005). "Strategic risk positioning as sensemaking in crises: the adoption of electronic trading at the London international financial futures and options exchange", *The Journal of Strategic Information Systems*, vol. 14, no. 1, 45-68.
- Segars, A. H., Grover, V. and Kettinger, W. J. (1994). "Strategic users of information technology: a longitudinal analysis of organizational strategy and performance", *The Journal of Strategic Information Systems*, vol. 3, no. 4, 261-285.
- Shang, S. and Seddon, P. B. (2002). "Assessing and managing the benefits of enterprise systems: the business manager's perspective", *Information Systems Journal*, vol. 12, no. 4, 271-299.
- Spohrer, J. and Riecken, D. (2006). "SERVICE SCIENCE: Introduction", *Communications of the ACM*, vol. 49, no. 7, 30-32.
- Tsang, M., Fitzmaurice, G., Kurtenbach, G. and Khan, A. (2003). "Game-like navigation and responsiveness in non-game applications", *Communications of the ACM*, vol. 23, no. 12, 56-61.
- Winston, P. H. (1980). "Learning and reasoning by analogy", *Communications of the ACM*, vol. 34, no. 11, 689-703.
- Zurk, L. M., Simons, B., Parsons, R. and Cohen, D. (1995). "When an advantage is not an advantage", *Communications of the ACM*, vol. 38, no. 12, 17-18.

Appendix 3

	Abstract					Body text				
	Narrative	Narrating	Narrator	Story	Storyteller	Narrative	Narrating	Narrator	Story	Storyteller
Agarwal and Lucas Jr				X					X	
Agre				X					X	
Baskerville and Pries-Heje				X					X	
Beusmans and Wieckert				X						
Cats-Baril and Jelassi				X					X	
Clausen	X					X			X	X
Crawford				X						
Danielson and Briggs				X					X	
Denning				X					X	
Dickson et al				X						
Ellingsen and Monteiro	X					X			X ¹	
Earnest				X						
Freeman and Urbaczewski				X						
Galliers				X		-	-	-	-	-
Giguette				X		X		X	X	
Glass				X						
Grover and Saeed	X					-	-	-	-	-
Harmon				X					X	
Hitchman	X					-	-	-	-	-
Iacovou and Dexter				X						
Introna						X ²			X	
Kuechler and Vaishnavi	X					X			X	
Lanzara	X					X				
Leidner and Jarvenpaa				X						

	Abstract					Body text				
	Narrative	Narrating	Narrator	Story	Storyteller	Narrative	Narrating	Narrator	Story	Storyteller
Madon				X					X ¹	
Madon et al				X					X	
Mansell	X									
Mason et al				X		X			X	
Mathis and Ives				X						
McBride				X		X			X	
McGrath	X					-	-	-	-	-
McKenny et al				X					X	
Mowery				X					X	
Nandhakumar				X					X	
Neumann				X					X	
Porra et al 2005	X					X			X	
Porra et al 2006				X		X			X	
Ramiller	X			X	-	-	-	-	-	-
Reich and Kaarst-Brown				X					X	
Roy and Lerch	X					X				
Scott and Barrett				X		X			X ¹	
Seagers et al	X					-	-	-	-	-
Shang and Seddon				X					X	
Spohrer and Riecken				X					X	
Sarker and Lee	X					X				
Tsang et al	X					X			X	
Winston				X					X	
Zurk et al				X						

1 Storytelling

2 Not an abstract

Sound from the Field: Narrativity to IS Research

Irja Tourunen

University of Jyväskylä, Department of Computer Science and Information Systems

iitourun@it.jyu.fi

Samuli Pekkola

University of Jyväskylä, Department of Computer Science and Information Systems

samuli@jyu.fi

Abstract. Narrating, or storytelling, is a profound characteristic of a human being. Telling a story to a friend and listening it are nice and pleasant activities. Can we achieve such mutual pleasantness when conducting IS research? Narrative research begins from an idea that such stories can be collected and analyzed in a manner that produces better, and especially deeper understanding of a phenomenon, which nevertheless is not generalisable. Despite this shortcoming, the understanding is still valuable since it provides insights in to the individuals' experiences and perceptions. These can be further be benefitted, for example, in UI or functionality design, organisational implementation, and general requirements specification. Maybe because of this lack of generalisation, narrative research approach is rarely utilized in IS research. In this paper, we discuss narrative research approach, its origins, practices, and utilization. We conclude by a statement that IS research may benefit by adopting narrative approach.

Keywords. Narrative research, research methods, IS research.

Introduction

There are bird feeders outside your window. You get interested in what is happening outside. What species of birds are coming to eat your seeds? How

many of them do you see in a day? How many different species are seen during a year? Which ones eat sunflower seeds, which nuts? Do they eat more in cold weather than in warm weather? Perhaps you are very curious to know more about what is happening at the bird feeders. Every bird looks the same when you look at it with the naked eye. But you get more and more interested. You decide to buy a telescope to see more and nearer. Is there variance in the individual birds? What kind of behavior can you recognize in different birds?

The above description of birds at a bird feeder resembles research in general. While some researchers prefer to see the phenomenon more from the distance and understand the whole, others want to see the phenomenon very close up and in depth. Both alternatives are equally interesting, both increasing the knowledgebase of the whole research community. Therefore, we need different tools and methods depending on our way of digging the knowledge out of the reality. Mintzberg (1979), for example, has stated we shall never understand the complex reality of organizations if we are studying them from the distance, in large samples with rough, cross-sectional measures. We can only learn how the birds fly if we study them one at a time, not by scanning them on radar screens.

Behind the organizational context there is always a human being or, accurately, many human beings and, in most cases, ordinary people who are trying to survive in the jungle of systems, devices and machines. To get a grasp on this jungle, different methods and means have been utilized. These are referred to as research methods. They have been classified as objective versus subjective (Burrell and Morgan 1979), as being concerned with the discovery of general laws versus being concerned with the uniqueness of each particular situation, as aimed at prediction and control versus aimed at explanation and understanding, as taking an outsider or an insider perspective. (c.f. Luthans and Davies 1982; Moray and Luthans 1984; Myers, 2007). In other words, differences in epistemological and ontological assumptions are emphasized. Most studies in Information Technology (IT) are concerning with experiences that human beings have with information systems or IT-artifacts in organizational or personal context.

IS research has started with methods from natural sciences. Thus, the research stance largely used in the IS field is positivistic, using quantitative methods. In IS research different methods have been adopted from other disciplines. Approaches to the reality vary from technical to organizational or human. Further, different paradigmatic approaches force researchers to utilize different research tools. Although quantitative research has been main stream research in IS communities, during the last decade also qualitative research has gain more interest and become more popular. Correspondingly methods like grounded theory, ethnomethodology, phenomenology, among many others, have been adopted to IS community. However, these methods may have weaknesses in capturing and describing individuals own experiences, i.e. how one *personally* perceives or experiences

something. Instead they, in many cases, rather aim at generalizing the phenomenon.

In this paper we are looking for new in-depth methods from a human perspective in IS research. The narrative approach is a popular and largely permeated method in other research fields like education and social sciences. Yet it has been adopted in IS community slowly. Why is that? It seems as if the dawning “narrative turn” with the name of “storytelling” in the 1990s was a flush of new paradigm but it never got under way. One can reasonably ask if there is something wrong with the narrative approach. Is it suitable for IS research at all? This paper tries to give some answers to these questions.

Next we will briefly summarize IS research methods and their paradigmatic foundations. Then the narrative research, as a research method, is presented, and studied whether there are any IS studies that use it in a way or another. Finally implications are discussed and conclusions drawn.

IS Research methodologies

Most studies in the IS field use quantitative methods or are design research. This limited view is also visible in the study by Vessey et al. (2002). They identified that majority of the literature in our distinguished journals (MISQ, ISR, JMIS) is focused on field studies and laboratory experiments, both areas that are often studied by quantitative methods. In recent years, there has been an increase of qualitative research also in the IS field. There has been a general shift in IS research away from technological to managerial and organizational issues (Orlikowski and Baroudi 1991). This has increased interest in the application of qualitative research methods. Thus, the lens to view the reality has become more human-centered: to understand people and the social and cultural contexts in which they live or work. (Myers, 2007) In order to understand how things function in organizations, the approach has mostly been organizational. To study the reality from this kind of larger perspectives has needed types of qualitative research methods such as participant observation, ethnographic methods, interviews or use of documents and texts derived from the organization.

The epistemological assumptions for quantitative research lie in a positivistic view. However, for qualitative research there are more paradigms in addition to positivism: post-positivism, critical theory, and constructivism (Lincoln and Guba 2000). Orlikowski and Baroudi (1991) suggested three categories: positivist, interpretive and critical. Assumptions in the background form the investigative stance and guide the whole research setting and model. Positivist research assumes that reality is objectively given and can be measured. Interpretative research starts out with an assumption that an access to reality is through social construction. Critical research assumes that reality is historically constituted, and produced and reproduced by people. This variance in epistemological and

ontological presuppositions has provided broader perspectives to the phenomena in organizations and its individual employees. Correspondingly, quantitative and qualitative research together has made the IS field very versatile. Researchers' special style and research domain can determine what kinds of approaches are possible.

Spoken language and written text have been approved to be as sources of data in place of numbers. However, there is still quite a lot of debate about the validity of the results acquired through qualitative methods, particularly if the paradigmatic approach has relied on critical research (Cecez-Kecmanovic 2001; Kvasny and Richardson 2006). Next, narrative research, that utilizes individual's personal stories, is discussed.

Narrative Research

The concept of narrativity came from literature and linguistics to social sciences during the 1980s. It has its roots in philosophy, literature and philology (Heikkinen, 2002). During the past 10 – 15 years, there has been a rising trend of narrative studies in social sciences. For example, the amount of dissertations using narrative methods have increased considerably. Indeed, researchers in social sciences speak about “the narrative turn” (Heikkinen, 2002; Riessman, 1993).

Narrating or storytelling is a profound characteristic of a human being. As having language, it is natural to tell about our feelings and experiences and structure the real world in narratives. (Atkinson, 2007; Clandinin & Rosiek, 2007) A narrative always responds to a question “and then what happened?” (Riessman, 1993). Mishler (1986) stated that human beings make sense of their experience by casting it in a narrative form. In academic discourse, the concept of narrativity has been used in at least four different ways (Heikkinen, 2002). First, it is used to refer to the process of knowing and the nature of knowledge. Narrativity is generally associated with the constructivist view of knowing. Second, it is used in describing the nature of research material. Third, narrativity refers to the means of analysis of the research material. Finally, the concept is often associated with the practical meaning of narrativity, where it is used in practical work, for example as means of psychotherapy.

Narrative research does not aim at objective or generalized knowledge but local, personal and subjective knowledge (Heikkinen, 2002). Narrative researchers, like qualitative researchers in general, are interested not in prediction and control but in understanding (Pinnegar & Daynes, 2007). In the philosophy of science, it represents relativism with many different truths and its epistemology lying in constructivism. It is acknowledged that people construct different narratives and they all are various views of the object under study. This is a paradigmatic change in thinking: we hear also the dampened voices (Lincoln & Denzin, 2000) that are not taken into account in “traditional research”. This is in

line with Bruner (1986), who identified two ways of constructing knowledge. First, we have the traditional way which tries to generalize. Second, there is a new narrative way that understands and acknowledges that every case is unique and special¹.

The way to acquire knowledge in narrative research (according to relativism and constructivism) sets the researcher in a new position. He or she is put on the same level as the informants. The research work is collaboration and dialogue between the informants and the researcher (Mishler, 1986). According to Polkinghorne (1995), narrative knowledge is a result of a series of constructions and the data is a result of a dialogue. Both parties have influence on the achieved knowledge about the phenomenon under exploration. In this respect, narrative research has similarities to action research, where, however, the object is to find something that can be generalized.

The key method in the dialogue is interviewing. In an interview in general there is always the question of using power. One needs to consider how much power is given to the field and how much is used by the researcher. The solution is obliged to the researcher's preconceptions, and refers to epistemological and ontological stances. In a narrative interview, the interviewer ought to be a passive but empathic listener and encourage the teller to continue his story. A narrative interview differs from a theme interview in that the interviewee constructs his or her story logically as a whole, while in a structured, theme-based interview the research problem has a more dominant role, consequently making it to seem more fragmented from the interviewee's perspective. In this respect, in narrative research the roles are intertwined, and the progress is more participative than in other methods. The informants are perceived as valuable sources of information as the researcher. In narrative research, the voice is first given to the interviewees while the researcher remains in the background. Later, in the analysis phase, the researcher becomes active. However, the interpretations rise from the dialogue between the researcher and the interviewees, in the form of communicative validation. (Wengraf, 2001)

In research activities there is always a question of validity. In qualitative research the concept of validity does not mean a process of technical calculations. This is much more true in narrative research where "valid" retains its ordinary meaning of well-grounded and supportable. Narrative research then uses the ideal of a scholarly consensus as the test of verisimilitude² rather than the test of logical

¹ In the context of case studies, Stake (2000) discussed about collective case studies in a manner that the cases might "... be similar or dissimilar, redundancy and variety each important. They are chosen because it is believed that understanding them will lead to better understanding, perhaps better theorizing, about a still larger collection of cases." [ibid., pp. 437] Hence, when conducting narrative research from several interviewees, it *may* be possible to find some common themes that can be generalized.

² Verisimilitude can be understood as something that has the appearance of being true or real.

or mathematical validity. (Polkinghorne, 1988) The process how the researcher constructs his or her report becomes crucial in narrative research.

Similarly to validity, also “significance” retains its more general meaning in narrative research. There a finding is considered significant when it is perceived important. In narrative research, reliability usually refers to the dependability of the data and validity to the strength of the analysis of the data. Consequently narrative studies do not necessarily have formal proofs of reliability, but they are instead relying on the details of their procedures to evoke an acceptance of the trustworthiness of the data (ibid). This makes narrative research extremely sensitive in its reporting phase, emphasizing the attitude of the researcher.

The analysis of narrative data does not follow an algorithmic outline but moves between the original data and the emerging description of the pattern the hermeneutic circle. Analysis is carried out using hermeneutic techniques for noting underlying patterns across examples of stories (ibid). In this respect, the search for commonalities and themes from the stories makes the analysis phase having much in common with the grounded theory techniques.

When comparing narrative research to research methods traditionally used in IS field, one may falsely argue it is easier to collect narrative data and conduct narrative research. This is argued against by Wengraf (2001), having done a lot of work in defining procedures for narrative research. He defined narrative interviews in a manner that they are not easier; they also must be fully planned and prepared. Participating to an interview “in depth”, i.e. really urging the informant to “tell a story” necessitates the interviewee to be more sensible and emphatic than in other interviewing techniques. This makes an apparently straightforward method in fact more complicated.

Narrativity in IS Research

If research methods used in papers that were published in MIS Quarterly or Information Systems Research during 1995 – 2005 are analyzed systematically, manually searching the methodology parts in every article, there is no evidence or even indication of narrative methods. Those leading journals have a long history in our field having formed their style in the earlier days of IS research (c.f. Vessey et al. 2002). From those two journals, one may say that narrative research seems to be fairly unknown and unused. In fact, places to find qualitative research are different journals than those two on the most top.

However, despite there has not been any narrative research in MISQ or ISR, narrative research might have been used elsewhere. It looks like something fairly loosely referred to narrative research have been in the air also in IS research. Words like “narrative”, “narrative and metaphor”, “storytelling”, “tale” and “stories” can be recognized in IS literature (e.g. Swap et al., 2001; Whittaker, 2001; Lutters, 2002; Hoffman and Herczeg, 2003), but they do not necessarily

refer to genuine narrative research per se. Instead, they utilize narrative research only as a method to collect data (similarly to psychotherapists who try to get the patient to tell a story).

Nevertheless, narratives and narrative analysis can be identified from IS research. One of the rare examples is the study by Alvarez and Urla (2002), who described how they used narratives in an enterprise resource planning project to collect information for requirement analysis. Actually, there were consultants to do the job by traditional ways but Alvarez tape-recorded extra narrative data that automatically emerged in all the interviews made by the analysts. This kind of “accidental” data was “messy” and uncodeable at the first sight, so the researchers decided to proceed its analysis in a narrative way. By doing so, they got a lot of profound information. First, narratives provided a pragmatic view of the information system, offering insight into the ways the system is actually used and the habitual practices of the work environment. Second, narratives function to signal the embeddedness of the information system in its larger organizational and social context. Especially for enterprise resource planning systems, being very client depending and integrated systems, narratives gave a lot of relevance in their study. The researchers concluded that they wanted to see the analysis phase similarly to anthropologists who should not ask for requirements but rather a good story in native terminology.

Alvarez and Urla referred to earlier IS research where narratives have been used and analyzed in the end of 1990s. They mention four articles (Brown, 1998; Brown & Jones, 1998; Davidson, 1997 (inaccessible); Dubè & Robey, 1999) that are dealing with IT implementation, failed IS project, sense making and interpretation in IS development project as well as in one software project. Actually, two of the articles (Brown, 1998; Brown & Jones, 1998) are from the same study. Stories are part of the data collection of Dubè’s and Robey’s research but their analysis is something else than narrative analysis. Back then Alvarez and Urla (2002) believed that this is to be the beginning of narrative revolution in IS research like it has happened in other disciplines. But the revolution has yet to come true. After Alvarez’ and Urla’s work there is still lack of narrative research in our discipline.

Concluding thoughts

As we have briefly identified, there has not been much narrative research in IS field. There must be reasons why we have not embraced narrative methods. Firstly, we believe there might be confusions in the key concepts of narrativity. Polkinghorne (1995) does not recommend using the word “story” in narrative research. He argues that the word “story” carries a connotation of falsehood or misrepresentation, as in the expression, “That is only a story”. The use of the term “storytelling” may have been inconsistent in IS research. It has brought the

narrative research closer to ordinary life, but at the same time, made it sound non-scholarly, less rigor and even relevant. This misunderstanding and confusion with the concepts can be one reason why narrative research has not permeated through our discipline. Urquhart (2001) warns that we cannot just take methods from other disciplines without profound understanding of the key concepts. We fully agree with this.

Secondly, narrative analysis is very arduous work. At first the data is very messy and uncodeable, so some tools are needed for handling it. The analysis of narrative research is not a rigid procedure either; we follow a hermeneutic circle (Polkinghorne, 1995). Many researchers in our field cannot understand this kind of looseness, which sounds less scientific when compared to more exact and well-defined procedures. Traditionally, it is more natural for us to use orderly specified procedures in IS research as well as in practical work. One of these examples includes grounded theory, which consists of rather well formulated instructions and guidelines that have been successfully adopted and merged into the accepted IS research practices. There the researchers can learn and have learned precise procedures from the literature. While, the usage of grounded theory methods have many gaps for misconceptions (Suddaby, 2006), they are now fairly much used in IS research. Urquhart (2001) had similar kinds of insights of how IS researcher adopt methods from other disciplines. According to her interpretation, it might well be that grounded theory technique has gained popularity in our field precisely because it does offer relatively well signposted procedures for data analysis.

Alvarez, who succeeded to collect narrative data and used narrative methods in analysis, had been working as a system designer for several years. This long time practical experience can be the reason why she understood the importance of deeper analysis. In addition, she made the study together with an expert of anthropology, which is always a good situation when we start to use methods and approaches derived from other research fields. Obviously having an expert on a certain methodology eases its use and adaptation. Urquhart (2001) used Melia's idea of "minus mentoring", when the method is learnt only from a book. She preferred situations where the researcher has a real mentor who is deep inside the method and its key concepts. Therefore, we should have more collaboration with our reference disciplines.

The main value of narrative research lies in its depth, and its relative new (in relation to the IS field) paradigmatic approach. Epistemologically, narrative analysis and data collection provide means for in depth, constructed understanding of the phenomenon. This understanding is difficult to achieve by using other methods. Therefore narrative research has its role in IS research, particularly when making requirements specification, designing user interfaces or systems functionalities, or when implementing systems in different organisational contexts and assessing the success of IS implementations and projects. In such cases, that require detailed understanding about individuals and their experiences

and perceptions, narrative research, we believe, may provide a new supplementary way to approach the topic. By understanding individuals in this manner does not necessitate generalisations outside the context where the individual lives. Yet this understanding may promote our understanding in general.

We have adopted many approaches and methods from other disciplines. The IS field does not differ from those sciences which study organizations and human behavior. Our particularity lies in the IT artifacts that people implement and use. However, studying humans and their behavior remains the same. Our advantage in IS research is that we can adopt research methods from other fields. If the narrative approach is widely used in other disciplines, why not adopt it to serve in the IS research field as well? This is similar than using a telescope to observe birds: probably it was not invented for that purpose but it is a very good instrument also for that activity.

References

- Alvarez, R., Urla, J. 2002. Tell Me a Good Story: Using Narrative Analysis to Examine Information Requirements Interviews during an ERP Implementation. *The DATA BASE for Advances in Information Systems* 33(1), 38-52.
- Atkinson, R. 2007. The Life Story Interview as a Bridge in Narrative Inquiry. In: *Clandinin, D.J.(Ed.) Handbook of Narrative Inquiry. Mapping a Methodology*. Thousand Oaks: Sage, pp. 224 – 245.
- Brown, A. 1998. Narrative, Politics and Legitimacy in an IT Implementation. *Journal of Management Studies*. Vol. 35, No. 1, pp. 35-59.
- Brown, A. & Jones, M. 1998. Doomed to Failure: Narratives of Inevitability and Conspiracy in a Failed IS Project. *Organization Science*. Vol. 19, No. 1, pp. 73-88.
- Bruner, J. 1986. *Actual minds, possible worlds*. Cambridge: Harvard University Press.
- Burrell, G. and Morgan, G. 1979. *Sociological Paradigms and Organisational Analysis*, Heinemann, London.
- Cecez-Kecmanovic, D. 2001. Doing critical IS research: the question of methodology. In: E.M.Trauth (ed.) *Qualitative Research in IS: Issues and Trends*. Idea Group Publishing. pp. 141-162.
- Clandinin, D.J. and Rosiek, J. 2007. Mapping a Landscape of Narrative Inquiry. In: *Clandinin, D.J.(Ed.) Handbook of Narrative Inquiry. Mapping a Methodology*. Thousand Oaks: Sage, pp. 35 – 75.
- Dubè, L. & Robey, D. 1999. Software Stories: The Cultural Perspectives on the Organizational Practices of Software Development. *Accounting, Management and Information Technology*. Vol. 9, pp. 223-259.
- Heikkinen, H. 2002. Whatever is Narrative Research? In: Huttunen, R., Heikkinen, H.L.T., Syrjälä, L. (eds.) *Narrative Research. Voices of Teachers and Philosophers*. Jyväskylä: SoPhi, 13-28.
- Hoffmann, P. & Herczeg, M. (2003). Distributed Storytelling for Narrative in Spacious Areas. In: *Proceedings of TIDSE, 1st International Conference on Technologies for Interactive Digital Storytelling and Entertainment*. Darmstadt, Germany.
- Kvasny L. and Richardson, H. 2006. Critical research in information systems: looking forward, looking back. *Information technology and people*, 19(3), pp. 196-202.

- Lincoln, Y. & Denzin, N. 2000. Seventh moment. In: Denzin, N. & Lincoln, Y. (Eds). *Handbook of qualitative research*. 2nd edition. Thousand Oaks: Sage, pp. 1047–1065.
- Lincoln, Y.S. and Guba, E.G. 2000. Paradigmatic controversies, contradictions, and emerging confluences. In N.K. Denzin and Y.S. Lincoln (eds.) *Handbook of Qualitative Research*, Sage, Thousand Oaks, pp. 163-188.
- Luthans, F. & Davis, T.R.V. 1982. An Idiographic Approach to Organizational Behavior Research: The Use of Single Case Experimental Designs and Direct Measures," *Academy of Management Review* (7:3), pp. 380-391.
- Lutters, Wayne G. 2002. Storytelling in Collaborative Work: Design Challenges for Capturing and Representing Sensitive Interactions, *Workshop: Storytelling and Collaborative Activities*, ACM Conference on Computer-Supported Cooperative Work (CSCW), 2002.
- Mintzberg, H. 1979. *The Structuring of Organizations: A Synthesis of the Research*. Englewood Cliffs: Prentice Hall.
- Mishler, E. G. 1986. *Research Interviewing: Context and Narrative*. Cambridge, Massachusetts and London: Harvard University Press.
- Morey, N.C. and Luthans, F. 1984. An Emic Perspective and Ethnoscience Methods for Organizational Research, *Academy of Management Review* (9:1), pp. 27-36.
- Myers, M.D. 2007. Qualitative Research in Information Systems. *ISWorld Section on Qualitative Research*, <<http://www.qual.auckland.ac.nz/>>[15.3.2007]
- Orlikowski, W. and Baroudi, J. 1991. Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research*. Vol. 2, Issue 1, pp. 1-28.
- Pinnegar, S. and Daynes, J.G. 2007. Locating Narrative Inquiry Historically. In: *Clandinin, D.J. (Ed.) Handbook of Narrative Inquiry. Mapping a Methodology*. Thousand Oaks: Sage, pp. 3 – 34.
- Polkinghorne, D. 1995. Narrative configuration in qualitative analysis. In: Hatch, J.A. and Wisniewski, R. (Eds.) *Life History and Narrative*. London: The Falmer Press.
- Polkinghorne, D. E. 1988. *Narrative Knowing and the Human Sciences*. New York: State University of New York Press.
- Riessman, C. K. 1993. *Narrative Analysis*. Newbury Park: Sage.
- Stake, R. 2000. Case Studies. In: N. K. Denzin and Y. S. Lincoln (Eds.) *Handbook of Qualitative Research*. Sage Publications, Inc., 435-454.
- Suddaby, R. 2006. From the Editors: What Grounded Theory is not. *Academy of Management Journal*. Vol. 49, No. 4, pp. 633 – 642.
- Swap, W., Leonard, D., Shields, M., Abrams, L. 2001. Using Mentoring and Storytelling to Transfer Knowledge in the Workplace. *Journal of Management Information Systems*, Vol. 18, No. 1. pp. 95 – 114.
- Urquhart, C. 2001. An Encounter with Grounded Theory: Tackling the Practical and Philosophical Issues. In Trauth, E. (Ed.) *Qualitative Research in Information Systems: Issues and Trends*. London: Idea Group Publishing.
- Vessey, I., Ramesh, V., and Glass, R.L., 2002. Research in Information Systems: An Empirical Study of Diversity in the Discipline and Its Journals, *Journal of Management Information Systems*, 19 (2), pp. 129-174.
- Wengraf, T. 2001. *Qualitative Research Interviewing. Biographic Narrative and Semi-Structured Methods*. Thousand Oaks: Sage.
- Whittaker, L. 2001. *Information Systems Evaluation: a post-dualist interpretation*. PhD dissertation. University of Pretoria, South Africa. Available at: <http://upetd.up.ac.za/thesis/available/etd-06142002-121347/unrestricted/00body.pdf>

An Activity Theory based framework for enhancing of User ‘Conscious’ Learning in Information System Development

Author (s): Tjonga Selaolo, Phd Research Student
Affiliations (s): University of Pretoria, Informatics Department
Email address(es): tjongabangwe@yahoo.com

Abstract

This research is concerned with the ‘meaning-making’ that results from the information system development (ISD) process as well as the individual learning and development of all ‘social actors’, with particular reference to users. The research adopts Activity Theory (AT) as analytical lens for understanding the complexities, misfits, and contradictions found in ISD as practiced in Botswana. AT is a socio-cultural and socio-historical framework that draws its roots from Vygotsky whose position was that humans construct meanings as they interact with artefacts and social others in their social (‘real-world’) environment and hence viewed learning as ‘mediated action’.

Botswana as with most developing countries recognises the strategic value of ICTs (information and communication technologies) and their potential to spearhead socio-economic development. It is my view, however, that sustainable socio-economic development can only be achieved if human leaning and development are key objectives in the implementation of ICTs. Three ‘real word’ ISD cases in Botswana will be analysed and through action research, an AT based framework developed that is intended to enhance user ‘conscious’ learning or the internalisation of knowledge.

Keywords: Activity Theory, Information Systems Development, Learning and Development, Action Research

1. Introduction and Background

1.1. Introduction

This research is concerned with the ‘meaning-making’ that results from the information system development (ISD) process as well as the individual learning and development of all those involved in such projects. The definition adopted here for ISD is that proposed by Korpela, Mursu and Soriyan (2002, p.115) that: ‘Information systems development (ISD) is the process by which some collective activity is facilitated by new information-technological means through analysis, design, implementation, introduction and sustained support, as well as process management.’

The research will take place in the context of a developing country, Botswana, which like most countries recognises the strategic value of ICTs (information and communication technologies) and their potential to spearhead socio-economic development.

The research will use a socio-cultural historical framework, Activity Theory (AT), for analysing ISD as a work activity. My intention is, through action research, to develop an AT based framework that enhances ‘conscious’ learning within ISD projects.

1.2. Background

Before presenting the problem statement, it is essential that some background information be provided on Botswana to demonstrate the context. Botswana is a self-governing, independent country that attained its independence from British rule after 80 years. It is a landlocked country, with semi-arid climate, spanning 582,000 square kilometers and borders Zimbabwe, South Africa, Namibia and Zambia.

Botswana has one of the fastest growing economies that pride itself in prudent economic management. In order to achieve this, Botswana has since independence being guided by successive national development plans (NDP) that normally span a six year period. The guiding principles for these plans which echo the interest areas for this research (bolded part), are stated as:

*'... all human beings are born free and equal in dignity and rights'; 'the right to development is a universal and inalienable right and an integral part of fundamental human rights'; **the human person is the central subject of development**; 'human beings are at the centre of concerns for sustainable development'; and that 'sustainable development as a means to ensure human well-being, equitably shared by all people, today and in the future, requires that the interrelationships between population, resources, the environment and development should be fully recognized, properly managed and brought into harmonious and dynamic balance'. (Botswana NDP9 (2003 – 2009), p. 13)*

The starting point for this research is that even at the micro level of ISD projects the 'human person should be the central subject of development'. And a by product of the ISD activity should be 'human development' which can be achieved through 'conscious' learning. Amongst the major policy thrusts of NDP 9 is the issue of public sector reform through such programmes as PMS (Performance Management System) and computerisation intended to make the public service more efficient. In order to guide these computerisation efforts, Botswana has just recently developed a National ICT policy, whose vision is that: "*Botswana will be a globally competitive, knowledge and information society where **lasting improvement** (bolding mine) in social, economic and cultural development is achieved through effective use of ICT*". (National ICT Policy, p.3, 2005)

This research posits that 'lasting improvements' can only take place when conscious learning that results in innovation has taken place.

1.3. ISD Practice

In the context of the Government of Botswana (GoB), the responsibility to develop policy and standards for deployment of ICTs in government resides with the Ministry of Communications Science and Technology (MCST) and more specifically the Department of Information Technology (DIT). A typical ISD project in the Botswana government will normally follow the ISD process as defined by Korpela et. al. (2002) to a certain extent, i.e. with four key phases: analysis, design, build and implementation, all underlined by some form of project, change and process management. In terms of the current ISD practice for large scale projects, Government departments often procure services of an independent consulting firm to carry out the analysis work. The analysis work usually entails business process review, review of any existing systems, requirements elicitation and specification. This specification document, known as the Statement of User Requirements (SOUR), is written in a simple business, non-technical language and is used as a basis for identification and selection of an IT Solution Provider (ITSP), to supply a package

solution and associated implementation services or to develop the solution from scratch, as would have been determined during the Analysis phase.

Because of the nature of the analysis brief, in most cases the consulting team from the 'Analyst firm' would of necessity comprise of a subject-matter expert (e.g. a Roads Engineer, Transport Management Economist etc.) to assist with the 'learning and understanding' aspects by the team. In some cases, the consulting team that was engaged in developing the SOUR is engaged to provide project management services for the ITSP responsible for the development and implementation of the solution. This situation arises mainly when the client wants to benefit from the technical ISD understanding of the 'Analyst firm'. It's important to note that in terms of this model, it is possible that the 'Analyst firm' and the ITSP may use different ISD methodologies and techniques. This in some instances presents a challenge for the users as the technical 'mediating tools' are now different.

1.4. Motivation and Problem Statement

ISD projects provide the best opportunity for learning and development of all stakeholders on the nature of IS and its potential for work improvement as it involves or should involve broad and extensive stakeholder consultations. This position is supported by Avgerou (2000, p. 569) when distinguishing the difference between the 'software engineering' and 'social perspectives' of systems development:

'Viewed from a social perspective, the development process is an intervention in an organisation to change the technical means and the information available to people's work. Such a perspective of the systems development process emphasises the importance of understanding the social dynamics that accompany the building or adopting of the technical systems and the organisational and social change related with the systems development project. *What matters in this approach is the improvement of the capacity of people to perform their work tasks in the context of their organisation.*' (Italics mine, for emphasis)

In the 15 or so years that I have been involved in ISD projects in Botswana and the region, where mainly structured techniques with a mix of participatory techniques have been used, it has not been obvious that 'conscious' learning has indeed been an outcome. In fact, I have always pondered over the following issues:

- What meanings do our clients / IS users assign to the ISD processes, methods and techniques?
- What is being learned or internalised and why?
- Do they learn anything beyond the use of the software application?

- How is what is being learned contributing to individual innovation and improvements to the work processes for which the IS solution is intended to facilitate?

This research posits that if indeed learning does take place, then this would result in innovative ways of doing work and thus ‘lasting’ work improvement. And thus my research interest is in trying to first understand if the current ISD practices which involve IS Users, ‘Analyst firms’, ITSP and other social actors, are resulting in ‘conscious’ learning or development of “higher psychological process” as suggested by Vygotsky and other Cultural Historical Activity Theorists (CHAT). And so the problem statement reads thus:

‘ISD practices employed currently in Botswana seem to provide limited opportunity for ‘conscious’ learning that could directly lead to individual human development and ‘lasting’ work and socio-economic improvements as espoused by the ICT policy vision ’

2. Literature Review

2.1. Activity Theory as a Framework for Analysing Information Systems Development

Korpela, Mursu and Soriyan (2002), applied an AT based framework (ActAD) and checklist to study information systems development (ISD) on a project in Nigeria. This was carried out as part of the INDEHELA methods project funded by the Academy of Finland. As a network of activity Korpela et. al. (2002) identify *IS Users, IS professionals, IS academics, Management* and *IS users clients* as the stakeholder groups that should typically be involved in an ISD activity. The *IS Users* provide the reason or motivation for the ISD activity and the outcome of the activity is intended to facilitate the work and life of the *IS users clients*.

An important aspect of the ISD work activity as described by Korpela et al. (2002) is that it is a boundary crossing activity in that it may involve IS users, professionals and user clients from different departments or even organisations e.g. IS professionals / user clients may be external to the IS users organisation. The reported results were that the framework was easily understood by the practitioners and they were able to apply it to their ISD work activity. They further observe that the application of ActAD was sufficient as a descriptive study since it was possible to draw meaningful conclusions on single case as well as multiple cases. The results of multiple cases could even be compared using this descriptive data. However, they note that to go

beyond a descriptive study to a more prescriptive and developmental study it is important to also analyse any contradictions, tensions and misfits that may arise from the multiple voices represented by the different social actors involved in the activity.

2.2. AT as a Framework for Analysing Learning and Innovation

According to Engestrom (2) 1999, p.377 'Innovative organizational learning is collaborative learning in work organizations that produces new solutions, procedures, or systemic transformations in organizational practices (Engestrom, 1995)'. The example that will be considered here is that which is based on Engestrom's expansive learning cycle. The expansive learning cycle, was developed based on Vygotsky's zone of proximal development and is said to be based on the dialectics of 'ascending from the abstract to the concrete'.

Engestrom identifies the following six learning actions that form an expansive cycle that is intended to resolve tensions and contradictions in an activity system.

- **Questioning**, whereby the social actors begin to question and criticize the current practice or way of doing things as it is viewed as being problematic
- **Analyses**, on the basis of the questioning at action 1 above, the social actors begin to analyse the underlying causes and internal relationships (i.e. actual empirical), or try to understand how the current practice was arrived at (i.e. historical-genetic)
- **Modeling**, involves development or construction of a new model or idea to resolve the problematic situation
- **Examining the model**, through trying out the new model so as to identify any limitations it might have in resolving the problematic situation
- **Implementing the model**, i.e. practical implementation of the model
- **Reflecting and Evaluating** the model so as to fine-tune and imbed it into work practice

Engestrom applied expansive learning on both large scale (i.e. 2-3 years) and small scale (i.e. minutes and hours) transformations in activity systems. In this example, Engestrom used activity theory together with the expansive learning cycle in the study of children's medical care in Helsinki, Finland. The findings were that throughout this activity where the patient and the challenge of illness were the collective object and motive of the activity there were contradictions and disturbances that led to the development of an expansive solution in the form of a 'care

agreement'. The 'care agreement' was intended to resolve identified conflicts and contradictions in the practice that existed then.

This solution was arrived at after a series of 10 sessions comprising of practitioners, patients and other social actors where the expansive cycle of learning cycle actions was evidently in use. Furthermore, Engestrom suggests that in his Boundary Crossing Laboratory observations for this particular study, there was horizontal or sideways learning and development.

2.3. Research Challenge

The literature review has provided instances where AT was applied to analyzing an ISD activity as well as learning and innovation. The challenge presented is not just to use AT in a descriptive manner, but to apply it in such a manner as to develop work improvements on the very ISD practices that will have been analysed. As already stated, the major issue of concern for this researcher is 'how much conscious learning actually takes place as a result of the ISD practices /methodologies that we use'? And so a major aspect of the application will be to analyse the "misfits", "tensions", "defects", "challenges", "conflicts" or "contradictions" between the various activity elements. The approach adopted for this research is to analyse the learning activity within the context of an ISD activity because as Mettinen (1999, p. 333) pointed out, learning takes place in the context of a societal activity, 'In sum, the object of learning activity is other societal activities. More precisely, the object of the learning activity is the generation and use of knowledge in solving vital societal problems.'

3. Theoretical Underpinning

3.1. Activity Theory History

Activity theory is said to draw its roots from the German philosophy of Kant and Hegel ‘... which emphasized both the historical development of ideas as well as the active and constructive role of humans’ (Jonassen and Rohrer-Murphey, 1999, p. 62). It is from this basis that the work of Vygotsky, Leont’ev and Engestrom was developed, which work forms the basis for activity theory. In terms of Vygotsky’s contribution to the development of AT, Yamagata-Lynch (2003, p.100-101) states:

‘In the early 1920s, Vygotsky attempted to reformulate psychology based on Marxian theory in order to understand the intricate relationship between individuals and their social environment (Cole, 1985; Wertsch, 1985)...Vygotsky theorised that individuals actively construct their understanding of the environment while engaging in goal-oriented activities. As a leader of this (constructivist) perspective, Vygotsky attempted to explain learning as a *semiotic process*, or *mediated action*, in his terms, in which individuals, or subjects, construct meaning while they interact with artefacts and social others in their environment. The dynamic interaction between these artefacts, individuals, and social others contribute to the social formation of the individual mind (Wertsch, 1985) and shapes individual knowledge construction. Vygotsky (1978) claimed that this semiotic process is a result of a mediated activity between signs, artefacts-tools, and the individual... When learning is identified as a semiotic process, the learner is no longer a passive recipient of information but is an active participant in his or her meaning making.’

According to Minick (1997, p.117), Vygotsky’s motivation was that the traditional psychologists were wrong in ‘...abstracting mind from behaviour, in trying to investigate the flow of ideas, perceptions, and associations in conceptual isolation from individual’s activity or behaviour.’ Vygotsky contention about the separation of the study of human behaviour from mind and consciousness was that it was, Minick (1997, p. 119):

‘Simply the dualism of subjective psychology – the attempt to study a purely abstracted mind – turned inside out. It is the other half of the same dualism. There, there was mind without behaviour; here, behaviour without mind. And both there and here “mind” and “behaviour” understood as two different phenomena (Vygotsky, 1982, p.81).’

Activity theory was developed by Vygotsky’s students and colleagues, including Leonte’v and Luria, in the late 1930s and early 1940s, as an attempt to address this issue of seeing mind and behaviour as separate and not an integrated object of psychological research. The central AT concept is the artifact-mediated and object-oriented actions that human beings engage in as they construct meanings of their environment.

3.2. Zone of Proximal Development

As with all his theoretical analysis and concept development, to arrive at the concept of the zone of proximal development, Vygotsky analysed three major positions on learning and development which he found wanting. These three positions were that:

- Position 1: Learning and child development were independent of each other and specifically that ‘learning lagged behind development’. Theorists holding this view included Piaget and Binet. An example is given of Piaget’s experiments where the underlying assumption is that ‘... processes such as deduction and understanding, evolution of notions about the world, interpretation of physical causality, and mastery of logical forms of thought and abstract logic all occur by themselves, without any influence from school learning.’ (Vygotsky, 1978, p. 80). As a result of this position all effort in schools has been focused on trying to assess whether a child’s mental functions have reached a certain level before instruction can be given
- Position 2: This came about so as to address the limitations with position 1 and assumes that ‘learning *is* development’ i.e. that learning and development coincide at all points. Proponents of this view include reflex theorists who view development as a mastery of conditional reflexes and learning merely as habit formation.
- Position 3: Theorist holding the third position posit that learning and development do not coincide, they are said to be different but related processes i.e. one step in learning can result in two steps in development since what has been internalized through learning can have broader application than the instructional area itself. Theorists holding this position include Thorndike, Koffka and the Gestalt school.

Vygotsky rejected all three theoretical views and instead came up with the concept of the zone of proximal development. He argues that in addition to establishing the actual developmental level, the zone of proximal development must also be established. This he defines as Vygotsky (1978, p. 85-87):

‘...the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers...The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the “buds” or “flowers” of development rather than the “fruits” of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively ... what is in the zone of proximal development today will be the actual developmental level tomorrow – that is, what a child can do with assistance today she will be able to do by herself tomorrow.’

Vygotsky arrived at this finding through experimentation and observations of two eight year old children which proved that two children of the same actual developmental level had different mental development capacities. He therefore argued that determining both the actual developmental age and the zone of proximal development allowed predictions to be made about the future development pattern and further stated that, Vygotsky (1978, 89):

‘... learning which is oriented toward developmental levels that have already been reached is ineffective for the child’s overall development. It does not aim for a stage of the developmental process but rather lags behind this process. Thus, the notion of a zone of proximal development enables us to propound a new formula, namely that the only “good learning” is that which is in advance of development.’

Vygotsky’s view is that though learning is not development, learning contributes to the development of human mental and psychological functions. His position was therefore, that ‘learning lags development’ not in a linear or parallel manner, but through complex psychological relationships.

3.3. The Activity System

In activity theory and more specifically in work development research, which was the main development of Engestrom (1987), the unit of analysis is the activity, and the components of any activity are organised into activity systems, as illustrated in Fig 1.

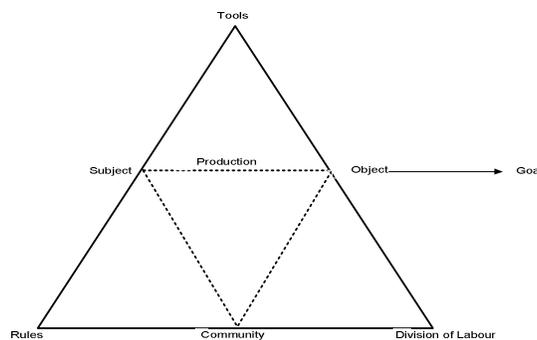


Figure 1: Engestrom's Activity System

It should be noted that the top triangle of this activity system by Engestrom is identical to Vygotsky’s original mediated action triangle. And so as depicted here, the components of activity theory are: Object (with a specific goal), subject, tools, rules, community and division of labour. The object is the reason or basis for which the

subject engages in an activity. The subject could be an individual or groups of individuals, who use tools/signs (i.e. external/internal) to transform the object into the desired goal or outcome. The rules in the AT system are the rules, regulations or procedures that should be adhered to and are acceptable practice to the community members that the subject belongs to while participating in the specific activity. And finally, the division of labour as the name suggests is how the specific tasks of an activity are divided or shared amongst the community members. Associated with this activity system model is the hierarchical model of activities, which was developed by Leont'ev and is depicted in Fig 2.

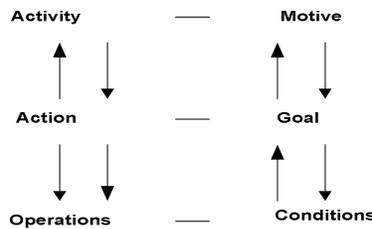


Figure 2: Leont'ev's Hierarchical model of activities

This model captures the fact that activities consist of goal-oriented actions that are completed through operations influenced by specific conditions. About this Yamagata-Lynch (2003, p. 102) state:

'A.N. Leont'ev, one of Vygotsky's disciples who contributed to the development of activity theory in Russia, contended that a subject's activity and its corresponding conditions, goals and means are the middle link between the organism and its environment (Leont'ev, 1974). This middle link is difficult to record in empirical studies because even though the activity itself is visible, the conditions, goals, and means are not visible in the overt behaviour of the subject. To make this middle link more apparent, Leont'ev developed his well-known three-level scheme that addressed the relationship between observable human behaviours of activity-action-operation, which are correspondingly contingent on the non-observable human terms of motive-goal-instrumental conditions.'

3.4. Internal Contradictions and Multiple Perspectives

The activity system by its very nature will offer multiple perspectives resulting from the different motives / goals of the various social actors / subjects. There may even be internal contradictions between the components of the activity system itself. About this Yamagata-Lynch (2003, p.104) states:

'Activity systems are not stable and harmonious systems; instead, they can be described by inner contradictions caused by tensions among the components of the system (Cole & Engestrom, 1993; Engestrom, 1987, 1993). These tensions arise when the conditions of components cause the subject to face contradictory situations that hamper the attainment of the object. In other words, the working conditions that a subject faces in an activity system may not favour the attainment of the object because of the conditions that one component creates for other components.'

3.5. Conclusion

This section presented the origins of AT including key concepts on the zone of proximal development, the activity system as well as internal contradictions and multiple perspectives that may exist in activity systems. The AT system described will form the basis for the descriptive analysis of the ISD activity in Botswana. It is the intention to use the zone of proximal development concepts to develop the AT-based framework that will be the key outcome of this research.

4. Research Approach and Methodology

4.1. Research Approach

In IS research there are three commonly accepted research paradigms positivist, interpretive, and emancipatory (e.g. Activity Theory, Critical Social Theory). The positivist research paradigm, which has its roots in logical positivism and scientism, suggests that reality is out there and ‘objectively given’, and research according to this paradigm proceeds from a position that the researcher can be / or is independent of the research subject and that information about the subject can be obtained through measurement and experimentation. The most common research methods associated with this paradigm are laboratory experiments, surveys and case studies.

The interpretivist paradigm, on the other hand, assumes that reality is socially constructed (ontology) through human understanding and through things like language, culture, and individual consciousness. Its epistemology is that of relativism. It suggests that researchers can be subjective in their research and be part of the research processes. It takes the approach that one need not be mechanistic (or machine-like) in their approach to research but need to apply their human understanding and perspective. Common research approaches include those that allow for engagement and extensive interaction with the research subject in ‘situ’ or in their natural setting / environment e.g. participant observation (overt or covert), action research and consultancy.

The emancipatory tradition has many streams that include critical social theory, feminism and even activity theory. Activity theory can be classified as such an emancipatory research paradigm because it draws its roots from Marx, Hegel and Vygotsky. As stated earlier Vygotsky was one of the ‘... the first psychologists of his time, along with Piaget, to assume the constructivist epistemology. From this constructivist perspective, Vygotsky theorised that individuals actively construct their understanding of the environment while engaging in goal-oriented activities.’(Yamagata-Lynch, 2003, p. 101)

In terms of this research, activity theory is both the research paradigm as well as the analytical framework for analysis.

4.2. Research Methodology

Action research will be adopted as the research methodology, which, according to Baskerville and Wood-Harper (1996, p.235) ‘... is widely cited as an exemplar of a post-positivist social scientific research method, ideally suited to the study of technology in its human context.’ In particular Baskerville and Wood-Harper (1996, p. 240) suggest:

‘...that action research, as a research method in the study of human methods, is the most scientifically legitimate approach available. Indeed, where a specific new methodology or an improvement to a methodology is being studied, the action research method may be the only relevant research method presently available.’

Action research is most appropriate for this research study as it combines research with practice and hence complements activity theory which is being adopted as the analytical framework. AT, as already pointed out, advocates the study of activity systems in their real-life environment or ‘in-situ’.

The development of action research is credited to the works of Lewin (1951) and the Tavistock Institute. It has close links with systems theory and has found most relevance in the study of IS systems methodologies as demonstrated by its extensive use by Checkland (1981) in the development of soft systems methodologies. There are several variations of AR, but the one which is commonly used is the five-phase iterative process described by Susman and Evered (1978). The phases, which are preceded by the establishment of the research environment through acquisition of the necessary client agreements are: (1) diagnosis, (2) action planning, (3) action taking, (4) evaluation and, (5) specifying learning. Data collection methods associated with AR include: audio-taped observations, interviews, action experiments, participant written cases and diaries. In order to ensure acceptability of research results, the rigour in the data collection, documentation and analysis is very critical. Specifically, the analysis needs to have a solid theoretical basis so as to distinguish it from consultancy.

4.3. Data Collection

In line with the expectations of activity theory and action research, three real-life ISD projects will be used for this study. About this, Yamagata-Lynch (2003, p. 104) states:

‘... socio-cultural research takes place in **activity settings rather than laboratories** (bold mine). Activity settings are environments that reveal an individual’s activity in a specific setting, consisting of individuals with common goals (Gallimore & Tharp, 1990). Individuals are not included randomly in activity settings; the goals shared in the activity setting attract membership of

Tjonge Selaolo: An AT Based Framework for enhancing User Conscious Learning in Information System Development

certain individuals. Therefore, the activity setting determines the participants of a research investigation.'

The researcher in this case is an IS practitioner working as a consultant mainly in the areas of IS / IT Strategy development, Requirements Analysis and Specification and Project Management. As such the researcher will use AT as an analytical tool on some of the projects that the researcher will become involved with during the period of the research. Prior permission has been obtained from the relevant authorities as part of the establishment of the 'client-infrastructure'. The identified projects will be analysed using AT and specifically the activity system developed by Engestrom. In terms of this the initial ISD activity system is modeled at Fig 3.

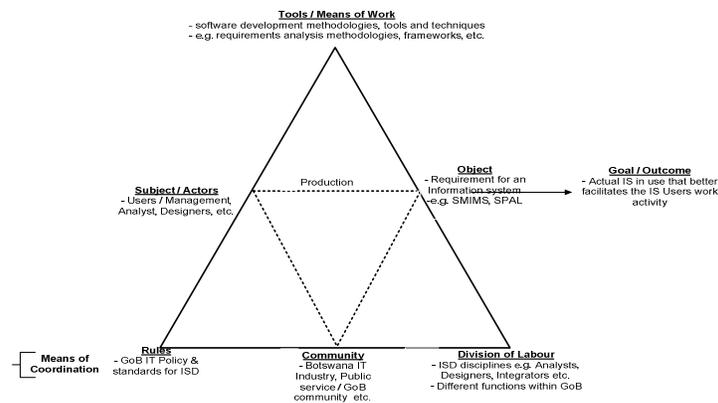


Figure 3: ISD Activity System

Research participants will be selected from the identified ISD projects. The data collection methods will include document reviews and analysis, semi-structured interviews / dialogues with individuals / groups. Identified subjects will also be asked to provide their own reflections on the projects specifically with regards to any learning, or contradictions in any of the AT components. The objectives of the interview / focus groups will be to shed more light on the ISD practice by breaking it down into the three-level model developed by Leont'ev i.e. for each activity identifying the specific actions and operations as well finding out what the motives for the activity are; the goals for the actions are; and the conditions for the operations. The interviews and observations will be preceded by workshops / meetings to present and explain the activity framework analytical tool.

Where there are contradictions, especially in the use of the mediating artifacts / tools, one would seek to find out if any new artefacts are being created, if they are

what are they and what specific areas are they being used in? This is in line with the following observation made by Engestrom (1, 1999, p. 26):

‘And it seems to be all but forgotten that the early studies led by Vygotsky, Leont’ev, and Luria not only examined the role of *given* artefacts as mediators of cognition but were also interested in how children *created* artefacts of their own in order to facilitate their performance (see Luria 1979).’

4.4. Data Analysis

In terms of the AR iterative process, the diagnosis and action planning aspects of the project will be carried out on the first two projects. Action taking, evaluation and specifying learning will be carried out using the third project. Throughout this process, qualitative data analysis techniques will be employed.

4.5. Researcher Role

As stated previously, the researcher is also a consultant on the projects that will be studied and hence engaged in some of the ISD process activities i.e. requirements analysis, project management etc. The project management role necessarily puts me on the side of the IS users and thus an active participant involved, amongst other things, in ensuring the quality of the ITSP products and services. Furthermore, the researcher has long standing relationships with some of the participants from the Department of Information Technology, as a previous employee of that department. In recognising and acknowledging these relationships upfront, one wants to ensure that the validity of the findings is not compromised in any way. But in terms of the adopted research paradigm, unlike with positivism, the ‘situatedness’ of the research often means that the researcher (as subject) cannot divorce themselves from the research (object). This research itself is modeled at Fig. 4 using AT:

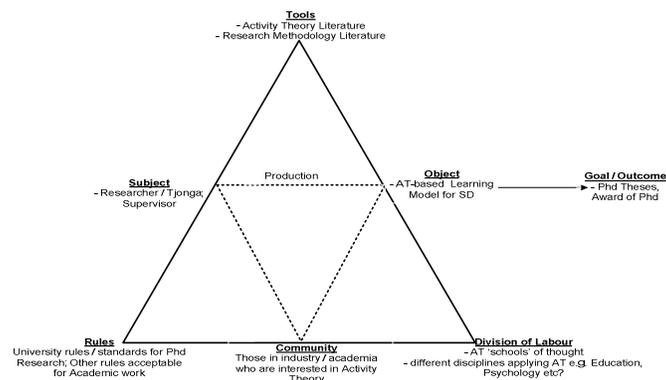


Figure 4: Research Study Activity System

5. Expected Contribution to Knowledge

This research study is intended to draw on and extend previous work done by others in analyzing ISD as a work activity. It is expected that its contribution will be in providing results, based on real-life and practitioner-led projects, that will lead to further development of AT theory in general. Another contribution will be the development of a framework for enhancing ‘conscious’ learning during ISD interventions.

In the context of Botswana, where the ISD projects are to be drawn, the expected contribution will be both in increasing the understanding of current ISD practices through the use of a socio-cultural historical theory, as well as benefiting from the development and application of an AT-based model that enhances ‘conscious’ learning and triggers individual innovation, amongst particularly the IS users. This should contribute to the country’s intent to develop the human person and thus achieve ‘...lasting improvements in social, economic and cultural development...’ as espoused by the National ICT Vision.

6. Research Plan

It is expected that the research study will be completed within a period of 4 years. The first two years will focus mainly on the diagnosis and action planning using two ISD projects and the last two years will be used for action taking, evaluation and specifying learning using the third project. Throughout the study, research results will be shared with peers in the academic community through conferences such as the IRIS 30.

7. References

- Avgerou, C. (2005). "Doing Critical Research in Information Systems: Some Further Thoughts", *Information Systems Journal*, vol. 15, 103 -109.
- Barrett, M., and Walsham, G. (2004). "Making Contributions From Interpretive Case Studies: Examining Processes of Construction and Use", in *Information Systems Research: Relevant Theory and Informed Practice, Proceedings of the IFIP WG 8.2 Conference*, pp. 293 – 312, Manchester, Uk.
- Baskerville, R.L., and Wood-Harper A.T. (1996). "A critical perspective on action research as a method for information systems research", *Journal of Information Technology*, vol. 11, 235 -246.
- Botswana, 2003. *National Development Plan 9*. Ministry of Finance and Development Planning, Gaborone, Botswana.
- Botswana, 2005. *National ICT Policy*. Ministry of Communications, Science and Technology, Gaborone, Botswana.
- Brooke, C. (2002). "What does it mean to be 'critical' in IS research", *Journal of Information Technology*, vol. 17, 49 - 57.
- Checkland, P. (1981). *Systems Thinking: Systems Practice*. J. Wiley, Chichester.
- Dayton, D. (xxxx). *Activity Theory: A Versatile Framework for Workplace Research*. ddayton@caribe.net, Project Web site: <http://english.ttu.edu/dayton/>, May 2006.
- Engstrom, Y., and Miettinen, R. (1999). "Introduction". In Y. Engstrom, R. Miettinen, and R. Punamaki (Eds.), *Perspectives on Activity Theory*, pp. 1-16. Cambridge University Press, Cambridge, Uk.
- Engstrom (1), Y. (1999). "Activity Theory and the individual and individual and social transformation". In Y. Engstrom, R. Miettinen, and R. Punamaki (Eds.), *Perspectives on Activity Theory*, pp. 19-38, Cambridge University Press, Cambridge, Uk.
- Engstrom (2), Y. (1999). "Innovative learning in work teams: Analysing cycles of knowledge creation in practice". In Y. Engstrom, R. Miettinen, and R. Punamaki (Eds.), *Perspectives on Activity Theory*, pp. 377-404, Cambridge University Press, Cambridge, Uk.

Tjonge Selaolo: An AT Based Framework for enhancing User Conscious Learning in Information System Development

- Engestrom, Y. (2000). "Activity Theory as a framework for analysing and redesigning work", *Ergonomics*, vol. 43 no.7, 960-974.
- Fitzgerald, B. (1996). "Formalised systems development methodologies: a critical perspective", *Information Systems Journal*, vol. 6, 3 -23.
- Fitzgerald, B. (1997). "The use of systems development methodologies in practice: a field study", *Information Systems Journal*, vol. 7, v201 -212.
- Hirschheim, R. and Klein H.K. (1989). "Four paradigms of information systems development", *Communications of the ACM*, vol. 32, no. 10, 1199 - 1217.
- Goulielmos, M. (2004). "Systems development approach: transcending methodology", *Information Systems Journal*, vol. 14, v 363-386.
- Korpela, M., Soriyan H.A., and Olufokunbi. (2000). "Activity Analysis as a method for Information Systems Development: General Introduction and Experiments from Nigeria and Finland", *Scandinavian Journal of Information Systems*, vol. 12, 191-210.
- Korpela, M., Mursu, A., and Soriyan H.A. (2002). "Information Systems Development as an Activity", *Computer Supported Cooperative Work*, vol. 11, 111-128.
- Korpela, M., Mursu, A., Soriyan A., Eerola A., Hakkinen H., and Toivanen M. (xxxx). *Information Systems Research and Development By Activity Analysis and Development: Dead Horse or Next Wave?*. Conference Paper, 453 – 471.
- Lindgren, R., Henfridsson, O., and Wood-Harper A.T. (2004). "Design principles for Competence Management Systems: A synthesis of an Action Research Study", *MIS Quarterly*, vol. 28, no.3, 435 -472.
- Lewin, K. (1951). *Field Theory in Social Science*. Harper & Bros, New York.
- Minick, N. (1997). "The early history of the Vygotskian school: the relationship between mind and activity", in M. Cole, Y. Engestrom, and O. Vasquez (Eds.), *Mind, culture, and activity: Seminal papers from the Laboratory of Comparative Human Cognition*, pp. 117-127. Cambridge University Press, Cambridge, Uk:.
- McGrath, K. (2005). Doing Critical Research in Information Systems: A Case of Theory and Practice not informing each other. *Information Systems Journal*, Vol. 15, pp 85-101.

Myers, M.D. (1997). “*Qualitative Research in Information Systems*”, <http://www.qual.auckland.ac.nz> , 28 March 2006.

Jonassen, D.H, and Rohrer-Murvey L., (1999). “Activity Theory as a Framework for Designing Constructivist Environments”, *ETR&D*, vol. 47, nNo. 1, 61-79, ISSN 1042-1629.

Stowell F. (1995). *Information Systems Provision: The contribution of Soft Systems Methodology (Soft Systems Methodology and its Relevance to the Development of Information Systems by Peter Checkland)*. MacGraw-Hill, London.

Susman, G. and Evered, R. (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly*, Vol. 23, pp 582-603.

Vickers, M.H. (1999). “Information technology development methodologies: Towards a non-positivist, developmental paradigm”, *The Journal of Management Development*, vol. 18, no. 3, 255 -272.

Vidgen, R. (1997). “Stakeholders, soft systems and technology: separation and mediation in the analysis of information system requirements” *Information Systems Journal*, vol. 7, 21-46.

Walsham, G., (2005). “Learning about being critical”, *Information Systems Journal*, vol. 15, 85-101.

Wastell, D.G. (1996). “The fetish of technique: methodology as a social defence”, *Information Systems Journal*, vol. 6, 25 - 40.

Westrup, C. (1999). “Knowledge, legitimacy and progress? Requirements as inscriptions in information systems development”, *Information Systems Journal*, vol. 9, 35-54.

Wynekoop, J.L., and Russo, N.L. (1997). “Studying system development methodologies: an examination of research methods”, *Information Systems Journal*, Vol. 7, p 47 - 65.

Yamagata-Lynch, L.C., (2003). “Using Activity Theory as an Analytical Lens for Examining Technology Professional Development in Schools”, *Mind, Culture and Activity*, vol. 10 (2), 100 - 119.

Vygotsky, L.S., (1962). *Thought and Language*. E. Hanfmann, and G. Vakar (Eds). The M.I.T. Press, Massachusetts, USA.

Tjonga Selaolo: An AT Based Framework for enhancing User Conscious Learning in Information System Development

Vygotsky, L.S., (1978). *Mind in Society: The Development of Higher Psychological Processes*. M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds). Harvard University Press, Cambridge, Uk.

Integrating Traceability in Qualitative Research

Dr. Nilay V. Oza

Helsinki University of Technology

Software Business Laboratory

nilay.oza@tkk.fi

Abstract. This paper focuses on the importance of traceability in qualitative research. The rationale of the paper reads that the empirical results in Empirical Software Engineering (ESE) qualitative studies often do not stand on their own in terms of verifiability of their results. To address this rationale, the notion of traceability is explained and reviewed for a typical qualitative research cycle. An example on integrating traceability in selecting empirical results is also presented. The paper finally presents recommendations for integrating traceability in empirical research. This paper should particularly offer some help to PhD students and 'young' ESE researchers undertaking their empirical case studies and qualitative research.

Keywords. Qualitative methods, Empirical research, Traceability, Rigour.

1. Introduction

There is nothing very radical about traceability. It may be considered as one of the quality attributes to improve the rigor of the qualitative research. Although it has been well applied in social science and medical science, it has not witnessed serious attention from ESE researchers. Particularly, in ESE, many qualitative studies fail to stand on their own. In other words, empirical models are proposed based on qualitative research but they fail to convince how exactly the models emerged to the presented state. It is often found that only a few variables appear as part of the model from the whole set of empirical results found in the empirical study. The question arises, how the results are carried forward to the outcome i.e. model or theory? In many papers, this is many times unclear for an external reader

or a reviewer. The intent in this paper is not to finger-point any particular paper or research practice. Rather, it is to indicate the importance of traceability in identifying qualitative research results, particularly in ESE research. Subsequently provisional recommendations on integrating traceability are proposed.

Traceability is referred to as the verifiability of the source of each 'outcome' proposed in different phases of qualitative research. The scope of this paper is certainly applies to ESE PhD students and 'young' ESE researchers. ESE PhD students often struggle to find the guidelines for developing rigor in their use of qualitative methods. The scope may also expand to ESE research community, where, researchers may take this position forward with necessary refinements and revisions.

The number of qualitative studies in ESE has been significantly low. Glass et al. in [1] discover that research method is the least diverse of the SE research categories. They quote:

'SE researchers tend to analyze and implement new concepts, and they do very little of anything else'.

Glass et al. analyze 369 research papers from some of the leading SE journals to investigate the state of SE research. Their investigation report less than 1% of studies using qualitative methods such as grounded theory or field study. Furthermore, only 1.6% papers were using exploratory survey. These figures give some indication of interest and exposure of SE researchers to qualitative research. However, there has been a slow but steady increase of qualitative research studies in SE. For example, my analysis into year 2006's Information and Software Technology (IST) journal suggests that there were at least 3 research papers in qualitative research category out of 96 research papers published. Although seemingly low number, it is approximately 2.15% of studies, representing qualitative research. Nonetheless, increasing number of ESE PhD theses are reporting the use of qualitative methods. It should be noted that the intent here is not to favor qualitative or quantitative methods but to contribute to the learning of the ESE community, particularly in effective use and knowledge transfer of qualitative research.

2. Measuring credibility of qualitative research

Basically, there is no major difference between how ESE researchers can use qualitative methods compared to other researchers from more established disciplines (at least in the context of qualitative research) such as social science. This gives ESE researchers, an opportunity to transfer research methods

knowledge from other disciplines. However, the effective transfer to ESE has been a subject to debate [2].

There is no set standard for verifying the quality of a qualitative research study [3, 4]. The quality of results is generally addressed by addressing three concerns [3, 4, 5] – integrity, objectivity and generalization.

2.1. Integrity

Patton in [3] suggests two ways to address integrity in qualitative analysis. The first way is to look for rival or competing themes and explanations in the patterns, and plausible explanations derived through inductive analysis. Rival explanations can be tested inductively or logically. Here, inductively means looking for other ways of getting the data that might lead to different findings. Logically means thinking about other logical possibilities and then seeing if those possibilities can be supported by the data.

2.2. Objectivity

The most frequent allegation about qualitative research is that it is inevitably ‘subjective’. Patton considers that to be subjective means to be biased, unreliable and irrational. Subjective data implies opinion rather than fact, intuition rather than logic, impression rather than confirmation. However, it is arguable if anyone or any method can be fully ‘objective’. In other words, *subjectivity is inevitable*. Guba in [6] has considered the issues of objectivity and subjectivity in considerable depth. He notes that in all areas of social science the data collected should be reliable, factual, and confirmable. He suggests that the issue is more clearly stated by talking about the ‘neutrality’ of the evaluator rather than objectivity or subjectivity. Patton notes that the point is to be aware of how one’s perspective affects fieldwork, to carefully document all procedures so that others can review methods for bias, and to be open in describing the limitations of the perspective presented.

2.3. Generalization

Patton points out that the small sample sizes involved in qualitative methods make it impossible to generalize results. Cronbach in [7] argues that empirical generalizations in social phenomena are too variable and context-bound. He also claims that ‘*generalizations decay*’. House’s [8] work concentrates on both the data evaluated and the report that is generated from it. His view of generalization is that findings are most useful with regard to the particular setting from which those findings emerged, and that the interpretation of findings is particular to those people who need and expect to use the information generated by evaluation research.

2.4. Extending the notion of credibility

The notion of credibility as proposed in the qualitative research literature [3, 4] does not seem to be directly addressing traceability issue. For example, Patton's view on documenting all procedures echoes the notion of traceability. Furthermore, arguments on context-bound generalization also indicate that results may not be effective if transferred too much beyond its evaluated context. Patton in [3], talks about transferability by suggesting that the empirical outcome should be transferable to the research problem or objectives initially established. This is indeed one way of looking at traceability of actual research results to planned objectives. Here, in this paper, the notion of traceability is taken in terms of verifiability of process and the results proposed by the qualitative research. In this context, by integrating traceability, credibility of the qualitative study may increase substantially.

3. Reviewing traceability

This section briefly reviews the existing recommendations in ESE. Then, a typical qualitative research design is described with the propositions on integrating traceability in it.

Figure 1 Excerpt from Kitchenham et al.'s guidelines addressing traceability issues

Context
C1: Be sure to specify as much of the industrial context as possible. In particular, clearly define the entities, attributes and measures that are capturing the contextual information.
C2: If a specific hypothesis is being tested, state it clearly prior to performing the study, and discuss the theory from which it is derived, so that its implications are apparent.
C3: If the research is exploratory, state clearly and, prior to data analysis, what questions the investigation is intended to address, and how it will address them.
Design
D1: Identify the population from which the subjects and objects are drawn.
D2: Define the process by which the subjects and objects were selected.
D3: Define the process by which subjects and objects are assigned to treatments.
D11: Justify the choice of outcome measures in terms of their relevance to the objectives of the empirical study.
Data collection
DC1: Define all software measures fully, including the entity, attribute, unit and counting rules.
DC3: Describe any quality control method used to ensure completeness and accuracy of data collection.
Analysis
A1: Specify any procedures used to control for multiple testing.
A5: Apply appropriate quality control procedures to verify your results
Presentation
P1: Describe or cite a reference for all statistical procedures used.
P2: Report the statistical package used
Interpretation
I1: Define the population to which inferential statistics and predictive models apply.

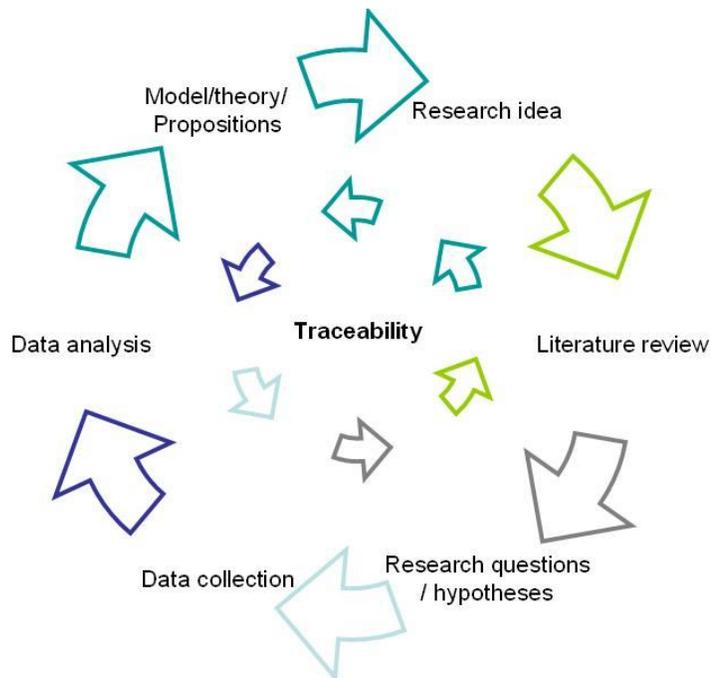
One of the exceptional research efforts on identifying guidelines for empirical research in ESE was done by Kitchenham et al. [9]. Indeed, they are very comprehensive and come from long research experience. The guidelines proposed in [9], however, focus mainly on empirical studies using statistical techniques. The guidelines stems mainly from the review of medical science research. Although these guidelines give excellent reference for ESE researchers, its scope seems to be limited in terms of pure qualitative research. The intent here, in this paper, is to further extend the existing guidelines [9] by proposing recommendations on traceability in ESE. The proposed recommendations indeed need further refinement and revisions by the ESE research community.

Kitchenham et al. propose guidelines on context, design, data collection, analysis, presentation, and interpretation. A set of guidelines are presented in Figure 1, which are particularly echoing the idea of traceability. For example, in Figure 1, C2 in 'context' emphasizes on linking hypothesis to its theory base. Similarly D2 and D3 in 'design', emphasize on defining the process for selection of subjects and objects and how they are assigned to treatments. The recommendations proposed in this paper on traceability complement with the existing guidelines presented by Kitchenham et al. [9] on conducting ESE research. They are reviewed later in the discussion section.

3.1. Research phases – qualitative research

Figure 2 shows the simple process of a typical qualitative design in empirical research and essentially in many doctoral research studies using qualitative design. Figure 2 shows two circles. Outer circle (with clock wise arrows) with different research phases shows how the research progress generally.

Figure 2. Traceability in empirical research



3.1.1. Research idea to Research question

Generally, the researcher starts with some researchable idea. S/he analyze the current body of knowledge i.e. the literature and sets the research questions that are inline with interest and that have potentials to contribute some novelty to the body of knowledge. This turns into a set of research questions or hypotheses that the researcher attempts to address through empirical work.

3.1.2. Data collection

The researcher prepares empirical research instrument to collect the data. It may include procedures and demographics on data collection procedures and study visits. Piloting of research instrument may be conducted before starting actual data collection. The main form of qualitative data sources come from interviews, observations (participant or direct), memos and documentary evidences. The data is recorded in some form such as through recording or taking notes etc. and prepared for analysis.

The collected data has to be prepared for analysis. The preparation includes organizing the qualitative data. Methods such as coding techniques proposed by grounded theory or content analysis may be used to categorize data.

3.1.3. Data analysis and model/theory building.

Coded themes are used for further analysis. Analysis is done based on some pre-determined strategy. A strategy is developed to carry forward particular results that qualify the criteria established in the strategy. The strategy may have more

than one phase of analysis. Empirical model is then developed depicting the most core or central themes identified through strategy implementation.

3.2. Ensuring traceability

Figure 2 shows the inner circle (with anti-clock wise arrows) in the reverse direction. It indicates that the model/theory should be traceable back to their roots. In this subsection, it is discussed that how the back-tracking traceability may be ensured.

3.2.1. Research idea to research question

Traceability in the research idea can be presented by clearly reporting the bases of the motivation in the proposed research issue. Of course, it may be an integration of several sources such as the matching educational or industrial background, the literature, talks with peers or a funding opportunity.

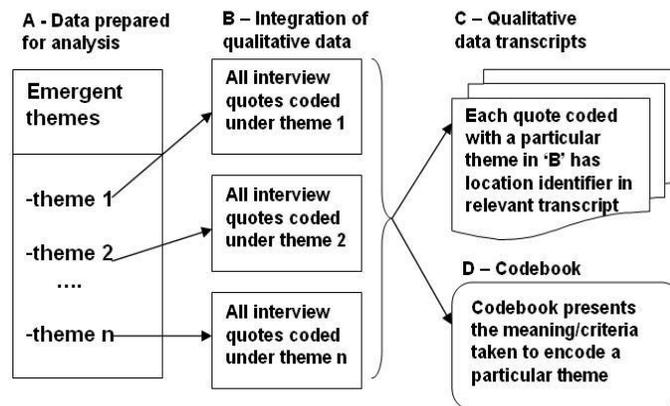
To proceed from research idea to research question, a researcher typically reviews the literature. Whatever the context, traceability may be integrated by clearly identifying and reporting the source for a particular research question or hypothesis. For example, a set research papers might have motivated the researcher to form a particular question. Researcher should clearly demonstrate such link by presenting the literature evidences and how one or some of them turned into the proposed research question.

3.2.2. Data collection.

Traceability in data collection can be assured by establishing a full account of all procedures relating to field study visits, interview questions, and organizing the collected data [also reflected in - 9, 3]. In qualitative research, typically, a researcher prepares transcripts, by documenting all collected qualitative data. Qualitative data are then categorized through coding techniques. Traceability may be assured by adequately linking all codes to their relevant locations in transcripts.

Figure 3 provides an example of integrating traceability in preparing collected data for the analysis. Figure 3 shows that a researcher may present the preparation of qualitative data in a way that gives verifiable links for emergent themes (A) to a group of quotes against which a particular theme has been coded from multiple transcripts (B). Furthermore, in (B), each quote transferred from a particular transcript should be referred with its location identifier of actual transcript (C). When codes and transcripts should also have verifiability to the codebook (D) to understand against which meaning/criteria a particular them has been encoded.

Figure 3. An example of integrating traceability in qualitative data



3.3.3. Data analysis and model building.

Data analysis is one of the most important parts to demonstrate the traceability. Figure 3 showed one common way of ensuring traceability from the collection of data to categorization of data. Here, the traceability should be integrated by identifying clear strategy on selecting empirical results. This means that on which basis a particular empirical result carries forward or drops out from the study should be verifiable. This verifiability should be maintained upto the specific results that qualify in the final outcome such as model or set of propositions. In this paper, a worked example is presented in section 4, to review the traceability in a purely qualitative data analysis.

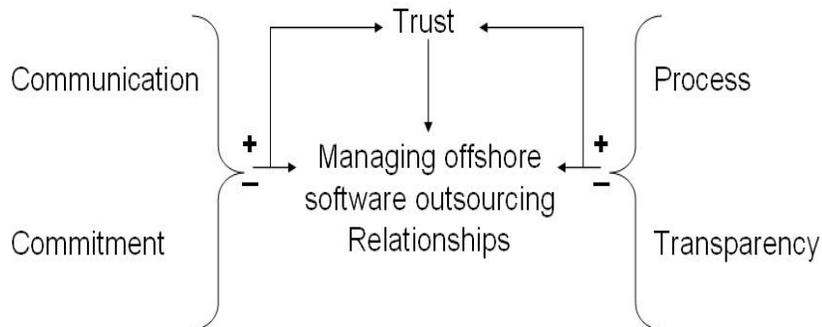
4. Integrating traceability – An example

In this section, an excerpt from the qualitative data analysis of an empirical study is presented. Specifically, the traceability is reviewed in selecting empirical results that qualify for the final model proposed in the empirical study. The empirical study example is an investigation of software outsourcing relationship practices in eighteen Indian software companies (i.e. vendor group) and eight of their client companies from the USA and Europe. More detailed account of research methods is proposed in [10]. An overview of research methodology used in the empirical study is presented here:

The underlying methodology uses multiple case studies, to collect and organize the overall investigation and grounded theory principles, to analyze and the collected qualitative data [4, 5]. Qualitative data from eighteen vendor companies and six of their client companies were collected by using Patton's recommendations [3] on qualitative interviewing. Interviews also included observations during the study visits. All interviews were audio recorded. They were transcribed for further analysis. Qualitative data was then analyzed using coding techniques of grounded theory methodology [5, 11]. Coding techniques including open coding, axial coding and selective coding were used [5].

One main result of the empirical study i.e. model is presented in Figure 4. It has four main variables – commitment, communication, process, consistency influencing the management of offshore outsourcing relationships and trust.

Figure 4. An example of the model proposed as an outcome of an empirical research in managing software outsourcing relationships



In this paper, however, the objective is not to explore or describe the model (Figure 4) but to back-track the process of how only certain empirical results i.e. communication, commitment, process and transparency qualified to appear in the model. Before proceeding to review the traceability of the model, the overview of research methods used in the study is presented here.

4.1. From results to model building – a worked example

This subsection takes through the selection of empirical results to the results presented in the model. This example is proposed to demonstrate one possible way of integrating traceability in conducting the analysis. In this section, a reader is taken through an exemplary procedure that gives one example of demonstrating traceability. Raw data, in the form of metrics, are presented in Appendix 1. The following tables can be traced through by applying mentioned criteria on the available raw data.

From the literature review, data collection and categorisation of the collected data, the study had two sets of themes for further analysis, those from the literature review and those from the empirical investigation. Table 1.1A and Table 1.1B show both sets. Appendix 1 shows the sets of themes with their replication frequencies across case companies in each group.

Using Table 1.1A and 1.1B, and tables presented in appendix 1 the main themes for the model are selected. A strategy was developed to select the themes that will qualify for the model.

Table 1.1A. Themes identified from the literature review

CSF - Rel. Mgmt.	CSF - Trust Building
Communication	Establishing structures
Cultural convergence	Communication setup
Personal relationship	Vendor's desire for contracting in future projects
Expectation management	Shared experience between client and vendor on other projects
Longevity of venture	Developing small system first
Mutual understanding	Background knowledge of key members from client-vendor organisation
Transparency	Visit of client delegation to vendor site
Flexibility	courtship
Commitment	Shared goal (project oriented)
Technical competence	Recruiting manager in vendor's language
Value addition	Working together in the project
	Project's early success
	Jointly celebrating completion of interim deliverables
	Showing tangible results

The strategy includes two phases:

Phase 1: A theme is selected if it satisfies at least one criterion from the following three criteria (in order):

Criterion 1: A theme identified by both groups in the study - client and vendor.

Criterion 2: A theme not identified by criterion 1 but is identified in at least half of the total number of cases in each group – client or vendor.

Criterion 3: A theme not identified by criterion 1 and criterion 2 but is overlapping with the theme identified in the literature.

Table 1.1B. Themes from the empirical investigation

	CSF - Rel. Mgmt.	CSF - Trust building	
		Achieving	Maintaining
Clients and Vendors	Communication	Reference	Commitment
	Process	Reputation	Communication
	Resource allocations	Personal visits	Confidentiality
	Expectation management	Investments	Performance
	Flexibility	Experience	Honesty
	Onsite presence		
	Meetings		
	Commitment		
Only Vendors	Cooperation	People background	Transparency
	Transparency		Demonstrability
	Consistency		Process
	Proactive		Consistency
	Domain expertise		Understanding
	Value addition		
	Demonstrability		
	Honesty		
	Confidentiality		
Only Clients	Payment	Presentation	Personal relationship
		Prototyping	Working together
			Documentation

The application of Phase 1 is presented here.

Applying criterion 1 - A theme identified by both groups in the study - client and vendor.

Using Table 1.1B, themes common to both clients and vendors are identified. The resulting themes are presented in Table 1.2.

Table 1.2. A theme that was identified by both groups - client and vendor

	CSF - Rel. Mgmt.	CSF -Trust building	
		Achieving	Maintaining
Clients and Vendors	Communication	Reference	Commitment
	Process	Reputation	Communication
	Resource allocations	Personal visits	Confidentiality
	Expectation management	Investments	Performance
	Flexibility	Experience	Honesty
	Onsite presence		
	Meetings		
	Commitment		

Applying criterion 2 - A theme not identified by criterion 1 but is identified in at least half of the total number of cases in one group – client or vendor.

By reviewing Table 1.1B, themes which replicated in more than half of the cases (and not identified by criterion 1) in client or vendor group were identified. Those themes were then reviewed with tables presented in Appendix 1 to discover the themes identified by at least half of the total number of cases in each group. Table 1.2A and Table 1.2B show the results.

Table 1.2A: Themes replicated in at least half of the vendor cases

	CSF - Rel. Mgmt.	CSF -Trust building	
		Achieving	Maintaining
Only Vendors	Cooperation		Transparency
	Transparency		Demonstrability
			Process

Table 1.2B: Themes identified in at least half of the client cases

	CSF - Rel. Mgmt.	CSF -Trust building	
		Achieving	Maintaining
Only Clients			Personal relationship
			Working together

Applying criterion 3 - A theme not identified by criterion 1 and criterion 2 but is overlapping with the theme identified in the literature.

Reviewing Table 1.2, 1.2A and 1.2B, firstly, themes which were not identified by criteria 1 and 2 are presented in Table 1.3.

Table 1.3: Themes which were not identified in criteria 1 and 2

	CSF - Rel. Mgmt.	CSF -Trust building	
		Achieving	Maintaining
Only Vendors	Consistency	People background	Transparency
	Proactive		Consistency
	Domain expertise		Understanding
	Value addition		
	Demonstrability		
	Honesty		
	Confidentiality		
Only Clients	Payment	Presentation	Documentation
		Prototyping	

Now, as suggested in criterion 3, Table 1.3 is reviewed against Table 1.1A i.e. the table presenting themes identified from the literature review). Resulting themes are presented in Table 1.3A.

Table 1.3A: Overlapping themes between Table 1.3 and Table 1.1A

	CSF - Rel. Mgmt.	CSF -Trust Building
Only vendors	Value addition	People background
Only clients		Prototyping

Integrating the results of three criteria of Phase 1

Results identified by applying three criteria are integrated and presented in Table 1.4. This completes the Phase 1.

Table 1.4: Resulting table for Phase 1 (Merging Table 1.2, 1.2A, 1.2B and 1.3A)

CRITERION 1	CSF - Rel. Mgmt.	CSF -Trust building	
		Achieving	Maintaining
Clients and Vendors	Communication	Reference	Commitment
	Process	Reputation	Communication
	Resource allocations	Personal visits	Confidentiality
	Expectation management	Investments	Performance
	Flexibility	Experience	Honesty
	Onsite presence		
	Meetings		
	Commitment		
CRITERION 2	CSF - Rel. Mgmt.	Trust building	
Only Vendors	Cooperation		Transparency
	Transparency		Demonstrability
Only Clients			Process
			Personal relationship
			Working together
CRITERION 3	CSF - Rel. Mgmt.	Trust building	
Only Vendors	Value addition	People background	Value addition
Only Clients		Prototyping	

Phase 2: Results of Phase 1 (presented in Table 1.4) are compared across CSF - Rel. Mgmt. and CSF-Trust Building themes. Overlapping themes between these two categories should be considered for the model. Reviewing Table 1.4, the overlapping themes are presented in Table 1.5. As a result, Communication, Consistency, Process and Transparency are selected for the model (presented in Figure 3).

Table 1.5: Overlapping themes in Table 1.4

CRITERION 1	CSF - Rel. Mgmt.	CSF -Trust building	
		Achieving	Maintaining
Clients and Vendors	Communication		Commitment
	Process		Communication
	Commitment		
CRITERION 2	CSF - Rel. Mgmt.	CSF -Trust building	
Only Vendors	Transparency		Transparency
			Process
Only Clients			
CRITERION 3	CSF - Rel. Mgmt.	CSF -Trust building	
Only Vendors			
Only Clients			

5. Recommendations and discussions

This section proposes a few provisional recommendations for maintaining traceability in ESE qualitative research. Some of the viewpoints presented in this paper are then discussed.

5.1. Recommendations

The recommendations are presented across the research phases presented in Figure 2. The proposed recommendations are only focusing on the traceability issues in ESE qualitative research as presented in this paper.

Research preparations (Research idea to research question)

R1 – Clearly define the motivations for the research.

R2 – Identify and document the literature (or other sources, if any) that turned into research question.

R3 – Demonstrate how you found the research problem from the literature (or any other source, if any) that you claim to have addressed your study.

Data collection

D1 – Identify and document all the procedures to collect the data including the data sources, study visit arrangements, case demographics, interview questions and actions to be taken in the field.

D2 – Show clear transfer of each quote in the transcript to next level i.e. assigning a particular code, grouping quotes from multiple transcripts for a particular code etc.

D3 – Maintain a comprehensive codebook where each coded theme can be verified for its meaning.

Data analysis

A1 – Once coded themes are available for analysis, show clearly how themes are being carried forward.

A2 – Develop a strategy to select themes for their further escalation and abstraction. Show the full worked example of the strategy implementation.

Model building

M1 – Clearly demonstrate the process of model development. Review if an external person can also reach to the same model using your proposed process.

M2 – Present how the proposed model addresses the research idea and the research problem you claimed to have addressed in the study.

M3 – State the scope, limitations and flaws (if you have found any) of the model and how it may impact the replication of the study.

5.2. Discussion and limitations

The traceability as a concept is not new in qualitative research. However, there is hardly any guide available for researchers to integrate traceability in their ESE research. Indeed the Kitchenham et al.'s [9] guidelines address many of the issues presented in this paper. The recommendations proposed in this paper may provide basic framework for ensuring traceability in qualitative research studies. Subsequently, they are complementary to Kitchenham et al.'s guidelines.

The research design presented in this paper is limited in the sense that (in Figure 2) it only presents a general scenario. However, it doesn't mean as rigid sequential research process. The intent is to show the traceability in each research phase. In qualitative research, there is often overlap between data collection and analysis, making it more a parallel activity than a sequential activity. Furthermore, for example, in grounded theory, a researcher collects some data, analyze them and propose the model and then further refine the model until the model saturates theoretically. However, the importance of traceability even increases when developing such model iterations. Another limitation is, probably because of the limited size of the paper, that the detailed account of the empirical context could not be presented in this paper and the empirical example was only kept limited to 'selecting empirical results' of data analysis.

This paper is also limited in terms of its application. The proposed recommendations are not comprehensive enough yet and formal guidelines on traceability require further revision on this paper. However, the proposition of ensuring traceability is an important contribution in ESE research. Furthermore, all the proposed recommendations are directly applicable in empirical work by ESE researchers.

6. Conclusions

This paper introduced the notion of traceability in qualitative research that may be useful in ESE. The paper explained typical qualitative research phases including research idea, literature review, data collection, analysis, and model building in relation to traceability concept. It was learned that the traceability may also strengthen the integrity and objectivity of the study. The paper took an example of the empirical study and showed one simple example of how traceability may be integrated in ESE qualitative research. Based on the worked example, and the literature, a few recommendations, particularly focusing on integrating traceability in ESE qualitative work were proposed. Recommendations included collection of implement-able statements across qualitative research phases. In summary the paper may help ESE researchers to address and integrate traceability in their qualitative research.

References

- [1] Glass, R. L., Vessey, I., and Ramesh, V. (2002). "Research in Software Engineering: an Analysis of the Literature", *Information and software Technology*, ELSEVIER, 44, 2002, pp. 491 -500
- [2] Sim, S. E., Singer, J., and Storey, M. (March 2001). "Beg, Borrow, or Steal: Using Multidisciplinary Approaches in Empirical Software Engineering Research", *Empirical Software Engineering*, Springer Netherlands, 6 (1), pp. 85-93
- [3] Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods*, Newbury Park, CA: Sage (2nd ed.).
- [4] Strauss, A., and Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, Thousand Oaks, CA: Sage (2nd ed.).
- [5] Yin, R. (2003). *Case Study Research*, Thousand Oaks, CA: Sage (3rd ed.).
- [6] Guba, E. G. (1978). *Toward a Methodology of Naturalistic Inquiry in Educational Evaluation*, Los Angeles: UCLA Centre for the Study of Evaluation (Monograph 8).
- [7] Cronbach, L. J. (1975). "Beyond the Two Disciplines of Psychology", *American Psychologist*, 30, pp. 116-127.
- [8] House, E. R., (March 1978). "Assumptions Underlying Evaluation Models", *Educational Researcher*, 7(3), pp. 4-12
- [9] Kitchenham, B., Pfleeger, S., Hoaglin, D., Emam, K., and Rosenberg, J. (August 2002). "Preliminary Guidelines for Empirical Research in Software Engineering", *IEEE Transactions on Software Engineering*, 28(8), pp. 721 – 734.
- [10] Oza, N. V. , Hall, T., Rainer, A. W., and Grey, S. (May 2006). "Role of Trust in Software Outsourcing Relationships", *Journal of Information and Software Technology*, 48, pp. 345 – 354.
- [11] Glaser, B., and Strauss, A. (1967). *The Discovery of Grounded Theory*, London: Weidenfield & Nicolson.

Appendix 1

This appendix shows the themes with their corresponding frequencies of replication across cases. In Criterion 2 of the Phase 1, these tables will be needed for identifying themes (those not identified by criterion 1 and) which are replicated at least half of the times across each group. The total number of cases in vendor group is 18 and 6 in the client group.

Table A1. CSF - Rel. Mgmt. for Vendor cases

Themes/Companies	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	Replication	
Communication	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	17
Process	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Resource allocation	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Meetings	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	11
Cooperation	1	1	0	0	0	0	1	1	1	0	1	1	1	1	1	0	0	1	1	11
Expectation management	0	1	0	0	1	0	1	0	1	0	0	1	0	0	1	1	1	1	1	9
Transparency	1	0	1	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0	1	9
Consistency	0	0	1	0	0	1	0	1	1	1	0	1	0	0	0	1	0	1	1	8
Proactive	0	0	0	0	1	1	0	0	1	1	0	1	1	0	0	1	1	0	1	8
Commitment	0	0	0	1	0	0	1	0	1	0	0	1	0	0	1	0	1	1	1	7
Value addition	0	0	1	1	0	0	1	0	0	0	1	1	0	0	1	0	0	1	1	7
Domain expertise	1	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	1	7
Demonstrability	0	0	1	1	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	6
Onsite presence	0	0	1	1	0	0	0	0	1	0	1	1	0	0	0	1	0	0	1	6
Honesty	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	1	0	0	0	5
Confidentiality	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
Flexibility	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2

Table A2. CSF - Rel. Mgmt. for Client cases

Themes/Companies	C1	C2	C3	C4	C5	C6	Replication
Communication	1	1	1	0	1	1	5
Resource allocation	0	1	1	0	1	1	4
Flexibility	1	0	0	1	1	1	4
Onsite presence	0	1	1	1	1	0	4
Expectation management	0	1	1	0	1	1	4
Process	0	1	1	0	1	1	4
Meetings	0	1	1	0	0	1	3
Payment	1	0	0	0	0	1	2
Commitment	0	1	0	0	0	1	2

Table A3. CSF – Trust Achieving for Vendor cases

Themes/Companies	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	Replication	
References	0	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	14
Experience	1	1	1	1	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0	9
Reputation	0	0	1	1	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	6
Personal visits	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	5
People background	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	5
Investments	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	4

Table A4. CSF – Trust Achieving for Client cases

Themes/Companies	C1	C2	C3	C4	C5	C6	Replication
Reference	1	1	1	0	1	1	5
Experience	1	0	0	1	1	1	4
Reputation	0	1	0	1	1	1	4
Personal visit	1	0	0	0	1	1	3
Presentation	0	1	0	0	0	0	1
Investments	0	1	0	0	0	0	1
Prototyping	0	0	1	0	0	0	1

Table A5. CSF – Trust Maintaining for Vendor cases

Themes/Companies	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	Replication
Transparency	1	1	1	0	0	1	0	1	1	0	1	0	0	0	0	1	1	1	10
Demonstrability	0	0	0	1	0	1	0	0	0	0	1	1	1	0	1	1	1	1	9
Honesty	1	0	1	0	1	0	1	1	0	0	0	0	1	0	1	1	1	0	9
Process	1	0	1	0	1	1	0	0	0	0	0	1	1	1	1	0	0	1	9
Commitment	0	0	1	0	1	0	1	1	0	0	1	0	1	1	1	0	0	0	8
Communication	0	0	1	0	0	0	1	1	1	0	1	1	0	1	0	1	0	0	8
Consistency	0	1	1	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	7
Understanding	1	0	1	0	1	0	1	0	0	0	0	0	0	1	1	1	0	0	7
Confidentiality	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	4
Performance	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	4

Table A6. CSF – Trust Maintaining for Client cases

Themes/Companies	C1	C2	C3	C4	C5	C6	Replication
Personal relationship	1	1	0	1	1	1	5
Performance	0	1	0	1	1	1	4
Working together	0	0	1	1	1	1	4
Honesty	1	0	0	1	0	1	3
Documentation	0	1	0	0	0	1	2
Commitment	0	1	1	0	0	0	2
Confidentiality	0	0	1	1	0	0	2
Communication	0	0	1	0	1	0	2

ERP Education in the IS Discipline – Is the Trend towards the Right Direction?

Timo Lainema

Turku School of Economics, Information Systems Science

timo.lainema@tse.fi

Kristian Kiili

Tampere University of Technology, Pori unit

kristian.kiili@tut.fi

Abstract. A common tendency in the discipline of Information Systems seems to be the tight involvement to a specific ERP system in the information systems curriculum. This tendency requires remarkable investments from both in terms of human resources and capital involved. The IS literature does not include critical research on the sensibility of the tendency. In this paper we put forward some criticism against the ERP university trend. Furthermore, we present an alternative teaching case which emphasizes the freedom from the heavy ERP systems and human resource investments. The suggested teaching case represents an alternative model and method for the prevailing ERP school tendency.

Keywords. Enterprise Resource Planning, IS Education.

Introduction

One of the most important IT-enabled business innovations during the past decade has been the emergence of enterprise resource planning (ERP) systems (Beatty and Williams, 2006). ERP systems seem to promise improved business productivity, streamlined business operations, and increased cost savings. Organizations worldwide have launched initiatives to integrate ERP systems into their existing business environments (Beatty and Williams, 2006).

An ERP system is an enterprise-wide management system. It is made possible by information technology. Organizations are implementing ERP packages for integrating the business processes in various functions. ERP is claimed to help companies to automate their entire business processes within the organization as a whole instead of just in some functional units. ERP systems have been found to help organizations to reduce cycle time, reduce inventories, and share information seamlessly across the organization. Companies that have implemented ERP have made improvements in cross-functional coordination and business performance at various levels (Rajagopal and Tyler, 2000). ERP software is the backbone of the manufacturing systems for production scheduling, materials management, and logistics planning (Saccomano, 1998). Sales of ERP systems are expected to reach around \$1 trillion (Bingi et al., 1999).

The huge success of ERP systems in the industry has also affected the IS education in universities and business schools. IS departments have felt that they are obliged to include the ERP thematic in their curricula. ERP systems integration to IS curriculum has been argued because of the ability of the ERP systems to serve as a focal point for integration of knowledge across functional areas (Johnson et al., 2004). Although these goals are all very welcome in the business school curriculum, we would like to note that these goals should not be realized with any cost.

In this paper we will first have look at research reporting the use of ERP systems in university education. In this we have selected a critical approach especially as the research often seems to be blind for the negative effects of the ERP training trend – shaping the universities into ERP schools depending on a certain ERP tool. After this we will introduce simulation gaming as a way to introduce business processes for the students. By giving the students a business process view on the functioning of a business organization the students also understand the application area and aim of the use of an ERP system. We will then introduce a business school teaching case and results from it implying that teaching the application area of ERP systems does not necessarily require the university to apply ERP systems in their curricula. Our results show that the students are able to grasp this application domain very well without hands-on experience on the actual ERP system. On the contrary, we would like to claim that the investment in a certain ERP system in the university teaching setting may be a poor investment because it seems to use resources that should be spent more productively on other teaching activities.

Potential ERP Systems Education Pitfalls

It is easy to find IS articles promoting, e.g. SAP R/3 investments in the university environment. For this research we found several journal articles which emphasized

the positive sides of such investments but these papers rarely introduced scientific data for their arguments. Mostly the argumentation was based on anecdotal comments which were not systemically collected. In this section we will introduce some typical examples of the ERP education fallacies.

First, when using huge amount of resources to implement ERP software and courses universities seem to bind themselves to a certain vendor. This situation is potential for value-laden education. For example, Becerra-Fernandez (2000, p. 41) describe the situation: *An ERP vendor may selectively choose university partners to be application service providers who will develop, support and provide system and associated coursework to other university partners who will buy Web-based access.* We question the role of a university as a partner for a software vendor. This kind of situation is very potential for critiqueless promotion of a certain software product.

Reading the articles we reviewed for this study revealed a religion-like faith for the specific ERP software and their suitability for university education. An example (Cannon et al., 2004, p. 95): *...an incentive plan designed to increase participation at three levels. The two highest levels, the “SAP champion” and the “SAP associate” require a 1-year commitment, discipline-specific SAP training, and the use of SAP in the classroom.* It is amazing how much blood, sweat, tears and toil academics are ready to tolerate to successfully get the ERP software working in the university setting (Cannon et al., 2004, p. 95-99): *This complexity, combined with a lack of faculty experience, resulted in early classroom use that lacked depth and was essentially limited to exercises adopted from other universities. ... the faculty took these [SAP] courses during the summer. This schedule often made it difficult for the faculty members to attend the most ideal courses. ...the training offered by SAP was practitioner focused and frequently lacked the theoretical background and depth needed... ...gaining a comfortable command of SAP was a struggle. ...students made mistakes and found themselves in territory unfamiliar to the faculty members. Thus, the introduction of SAP into the classroom was fraught with uncertainty. ...led to frustration among students as they attempted to gain competence. In addition, the students often questioned the relative worth of learning SAP and lacked enthusiasm. ...a smaller, more manageable company was developed. ...the effort would represent a significant time commitment, the dean provided monetary incentives. ... we encountered several unanticipated problems whose resolution took up considerable faculty time. ...more complicated and sometimes more frustrating than the faculty members had anticipated.*

Second, to be able to give a general picture of the application domain of an ERP system the system needs to be taught intensively and for a long period. This eats the IS departments' course offering. University level IS education should be, in our mind, kind of general education giving the students a wide apprehension of the different business topics and disciplines. The studies in the 1990s reported that

today's IT professionals need a combination of managerial, business, interpersonal, and technical skills to service their organizations. The IS organization has begun to play a service role by providing training, consulting, and trouble-shooting (Gupta & Wachter, 1998). The most important IS activity in the future should be to analyze business problems and IS solutions (Lee, Trauth, & Farwell, 1995). The mission of IS is shifting from developing and supporting information processing applications to developing, managing and supporting the information technology infrastructure for the entire organization. Trauth, Farwell, and Lee (1993) describe the employers' vision of the future IS professional as an integrator devoting as much effort to analyzing business problems as to developing technical solutions.

In their study, Lee et al. (1995) found out that among the highest rated skills of IS professionals in the future are: ability to learn about business functions, ability to interpret business problems and develop appropriate technical solutions, ability to understand the business environment, and knowledge of business functions. Thus, the skills in demand are features of general education. Work summarizes that practitioners regard information systems as essentially interdisciplinary. The most distinctive aspect of IS is not a single subject, but the relationship among several. This requires education which stresses the interconnectedness of all areas of learning rather than their separateness. Gupta and Wachter (1998) quest for education that would teach the students how different business subjects fit together and mutually impact one another. Furthermore, the socio-technical complexity of live organizations and the need of interpersonal skills should be captured.

Given the challenging nature of an optimal IS education, we are convinced that the aims introduced above will suffer if ERP teaching is given too much emphasis. The research reporting on ERP teaching shows both massive time and other resource investments on plain hands-on ERP teaching. If the ERP teaching is given a major role, time is definitely taken away from the teaching which should lead to more general education argued above.

Also Johnson et al. (2004) claim that using SAP as an integration tool in the curriculum comes with some cost. The initial configuration and ongoing maintenance of a customized SAP client require an advanced understanding. Also, the student companies in the Johnson et al. case required maintenance before each new semester (posting periods need to be closed; production materials need to be restocked; individual company functionality must be checked; student user accounts are deleted/created).

Third, the scale of an ERP software investment is often much too big for universities. Too often universities seem to think that they are obliged to purchase an ERP system for teaching purposes only because the other universities are doing the same thing. Universities seem to regard their ability to give ERP system teaching as a competitive advantage in the educational market, although when they have bound themselves to a certain ERP vendor just makes the teaching offering

narrower. Also, after the university has invested to certain ERP software, it is mentally very difficult to withdraw from using the software as so much has already been invested. For example, Becerra-Fernandez et al. (2000, pp. 40-41) describe the ERP implementation project: *Significant attrition caused by job changes, other interests, and lack of recognition of the work required to implement ERP in the classroom reduced this group [the initial ERP project team] to approximately five members. ... Acquiring adequate technical knowledge and support is indeed a challenging issue because of the high demand for trained professionals in this area. The CBA decided to train internal support personnel to administer the system, and one full-time graduate student currently supports the system. Professors and system-support personnel attended 105 days of SAP training during an 18-month period at a cost to the university of travel and per diem expenses. ... An effort of this magnitude requires a sizeable resource commitment to software, and hardware. There is a \$7,500 annual fee... ...a database system such as Oracle is required. ...a dedicated... server... was purchased at a cost of \$20,000. This server has since been updated... for an additional \$20,000. ... A further challenge for universities is to provide faculty with incentives commensurate with the effort that must be invested.*

Fourth, a university ERP system environment often lacks the basic and core elements of a workable training environment: the living market with customers and suppliers, and an on-going functioning production system. These elements provide a living environment which makes the use of an ERP system sensible. Without them the use of the ERP system is just unrealistic and hypothetical practising as the school ERP system environment is not going to illuminate reality with full complexity and dynamicity. As Johnson et al. (2004, p. 246) note: *One of the primary obstacles in using ERP software in the classroom is the difficulty in providing a meaningful set of data for student use.* Draijer and Schenk (2004, p. 262) reveal this weakness by stating: *The customers are simulated by the teachers. ... We give each company about ten sales orders per semester.* Johnson et al. (2004) note that finding a company willing to share real-world ERP system data – even historical – is difficult.

Fifth, we have serious doubts whether universities' task is to provide the students with application usage training. Universities should be organizations which provide their students with higher level understanding of business organizations' functioning and higher order reasoning capabilities, not that much to train the students to use specific tools. Sein et al. (1999) have suggested that training in the use of information technology needs to move towards an approach which encompasses knowledge at all levels from physical manipulation to conceptual and objective knowledge of how the tools can be applied. We agree with this and claim that a heavy use of ERP systems in the curriculum has too much focus on the physical use of the technology.

Furthermore, in case of ERP software, universities are most often only able to introduce some basic features of the system and the whole remains unstudied through the use of the system. As Draijer and Schenk (2004, p. 263) note: *Most students expected to learn everything about SAP... At the end of the project they know that this expectation is not realistic.*

None of the ERP teaching articles we read for this study provide evidence for the success of their ERP implementation projects. For example, Cannon et al. (2004, p. 101) contents to state: *The resulting improvements in curriculum integration and our ability to demonstrate business process integration are promising and ultimately provide the opportunity enhance student learning.* Or Johnson et al. (2004, 246): *Faculty reported that students generally felt that the use of ERP systems helped them gain a better understanding...* We could not see evidence for this. Although exposure to and experience with ERP systems is very beneficial to students as they enter the job market (Johnson et al., 2004), not enough effort has been put to consider whether this investment is away from some more important educational issues.

The Case of the Enterprise Informations Systems Course

We have applied a business simulation game on course Enterprise Information Systems in Turku School of Economics – during autumns 2005 (session A from this point forward) and 2006 (session B). The structure of the course has been quite the same on both of the occasions: the lectures form their own entity and the exercises their own. The lectures deal with general issues concerning enterprise information systems. During the exercises the students have both experiences an ERP system (SAP) and participated on a business simulation game introducing a manufacturing organization as a dynamic, process-oriented entity. The simulation game was used as a tool to introduce the students the management of the organizational functions with a typical enterprise resource planning (ERP) systems.

The exercise structure has been the following (autumn 2006; during 2005 there was one SAP session less):

- Simulation game playing, 5 hours
- MySAP ERP configuration, 4 hours
- MySAP ERP configuration, 4 hours
- MySAP ERP usage exercises, 4 hours
- MySAP ERP usage exercises, 4 hours
- Simulation game playing, 5 hours

The overall aim of the exercises was:

- During the first simulation session to inform the students what is the application area of a typical enterprise system (to give a holistic view on a

manufacturing organization including a full supply chain from suppliers to customer and a typical range of support functions like marketing, R&D, finance, management)

- During the SAP sessions give basic understanding of the configuration and usage of an ERP system with examples of how to deal with order-delivery transactions in the system
- During the second simulation session to illustrate to the students how demanding a dynamic business environment is and how difficult it is to set the system parameters, for example, in an inventory system (in the area of materials resource planning, MRP, an important part of a typical ERP system)

The simulation sessions and the ERP exercises were guided by two different persons. The simulation game in use was RealGame (<http://www.realgame.fi>). We argue for the use of RealGame by its ability to illustrate the process characteristics of organizations as summarized by Hammer (1996, pp. 5-6): *We are inflexible not because individuals are locked into fixed ways of operating, but because no one has an understanding of how individual tasks combine to create a result, an understanding absolutely necessary for changing how the results are created... In short, our problems lie not in the performance of individual tasks and activities, the units of work, but in the processes, how the units fit together into a whole.* The focus in the process view is on the attempt of communicating how an organization works together to create value for its customers, as opposed to how it is structured. RealGame is a clock-driven simulation game illustrating the flow of order-delivery transactions as a continuous process. RealGame also delivers a holistic view on the functioning of a manufacturing organization, including all the major functions in these kinds of organizations. More detailed illustrations on RealGame functionality can be found in Lainema and Nurmi (2006) and Lainema (2007).

The students (the number of students participating the second sessions and returning the home assignment was 102 in A and 96 in B) played the simulation game on two separate occasions. In the first occasions (5 hours), the students were responsible of managing the basic materials and monetary process of their manufacturing companies. The sessions lasted for one simulated month and there were 6 to 8 companies (= student groups) competing against each other in real-time over the computer network. There were from 2 to 4 students in each of the student groups. After this the students had three (A) or four (B) weeks of SAP exercises. After this, in the second occasions (again 5 hours), the students faced the same business environment with an additional end product (and an additional market area in A) and a faster clock-speed, creating a need to automate the order delivery process and the inventory management system with re-order points. The second sessions lasted approximately for 2.5 simulated months. The learning aim was to make clear that a dynamic and complex manufacturing process requires

automation and that this automation is a demanding planning process. The home assignment used in the analysis in this paper was given for the students after the second simulation session.

Data Gathering and Presentation

In the following we have analysed players' learning on basis of their reflection on the game experiences versus a description of a real world business case. The data is collected from the student home assignment answers, which reflect the students' understanding on the functioning of a business organization as a whole and different ERP issues within it. The body of the home assignment was the same both in A and B. The assignment consisted of eight different citations from different ERP research journal papers and questions linked to these citations. The research papers dealt with ERP system planning and implementation issues. In the questions the students were asked to reflect their experiences from the simulation game to the cases in the research papers.

The students answered to the questions mostly as groups of two or three students. In 2005 there were 32 and in 2006 34 students groups, 2 to 4 students in each group. We will analyse the student group answers to the following assignment questions:

- Question 2: *In spite of the latest developments of ERP software that provide a unified platform for managing and integrating core business processes within a firm, including SCM and CRM, the decision-making between marketing and production planning on the whole supply chain still remains rather disjoint (Botta-Genoulaz, Millet and Grabot, 2005). Why is this?* The question was preceded by Question 1 dealing with limitations of ERP and the incompatibilities between the software and business needs (Kumar, Maheshwari and Kumar, 2003).
- Question 3 introduced a research article describing the implementation of an ERP system in a manufacturing organization and problems arising from this in the manufacturing process (Boersma and Kingma, 2005). The students were asked: *What kind of similarities did you face in the second simulation session copared to the case text? What kind of similarities did the increased complexity [new product in the production process, increased simulation clock speed] in the simulation game introduce compared to the case text?*
- Question 4 introduced a case text dealing with the challenges related to the need of changing organizational structures in an ERP implementation project (Boersma and Kingma, 2005). The students were asked: *How does the change in your own awareness of the challenges in the management of the materials process suite the case text? For example, were you able to*

take over the parameterization of the automatic raw material orders at once or did you face problems?

In the following we will illustrate the student perceptions on the presented ERP issues. These perceptions are shown through analysing the student assignment answers.

Question 2: The decision-making between marketing and production planning on the whole supply chain still remains rather disjoint. Why is this? Below a couple of typical student answers:

- *First of all, often it is different people who decide on these issues and their views may differ from each other considerably. If there is no common melody, everybody will force their own views through in their own decision areas. This may lead to totally conflicting decisions in different functions. Secondly, despite of an ERP system, the flow of information may stumble because of insufficient reporting or some other issue, leading to insufficient information about the doings of the others. Thirdly, it is difficult for people to understand the whole production process without some investment in training the management of different functions.*
- *Connecting planning of marketing and production to the management of the whole delivery chain was not easy in RealGame either. This was probably partly because of the thing that in our company our attention was focused on several different issues, which in the current situation seemed to be more important. Sketching the whole picture did not succeed in the best possible way and for this the integration of different core processes was not successful.*
- *Based on our RealGame experience we would say that the reason is the fact that Customer Relationships Management and Supply Chain Management have different goals in a business organization, because CRM aims at good customer service, but this causes costs and time pressure on SCM, which does not then reach its optimal results. In the real world there are – besides of these interest conflicts – also other issues, like insufficient communication between the SCM and CRM departments.*
- *In general marketing and production planning are too much separated from each other, because information does not flow efficiently enough between these functions. Furthermore, often the reactions to changes in production and marketing come too late. In the game the outcomes from the decisions on marketing and production were not instantly visible, which lead to erroneous estimates. This was shown in too large inventories and as running out of the end products.*

The student comments on this question merely reveal that they have a clear understanding of the challenges in establishing fluent collaboration between different organizational functions and tasks. This understanding is probably stemming from courses and experiences other than the course under investigation

in this paper. In general, all the answers showed similar understanding and the students – at least in theory – did understand the existence and universality of the disharmony between organizational functions. This forms a sound basis to further open the problems in ERP implementation and use.

Question 3: *What kind of similarities did you face in the second simulation session compared to the case text? What kind of similarities did the increased complexity in the simulation game introduce compared to the case text?* This question produced a heap of interesting and illustrative answers. We will again present some of the most illustrating ones. Answers mentioning an ERP system in the refer to the automatic raw material purchase system with re-order points, which the students were supposed to set parameters for in the simulation game:

- *Compared to the game we see as a similarity our extensive order intake, which concretized as delivery problems in the beginning. This problem stemmed from the automatic delivery system, and was balanced soon when the game and the production of the different end products started... The planning of materials purchases worked better than in the first session, although we had problems in setting the parameters [for the automatic order system]... The complexity of the game increased through the introduction of the ERP system, bringing in a greater demand for planning the purchase function and the regional marketing.*
- *When we added the new product in the production process, it instantly increased the complexity of the game. In the first session we needed to manage the inventory needed for the production of two end products, but now we needed to estimate the demand for three end products as accurately as possible, so that the automatic order system would function without problems. It was problematic to decide the right production volume equalling the market demand.*
- *The case text includes several similarities compared to the gaming session. We also faced problems in estimating the demand, which lead to over-sized inventories and on the other hand unnecessary production start-ups and closedowns... The introduction of the ERP system in our organization caused some problems similar to the ones described in the case text. We could not maximally benefit from the ERP functionality in the beginning. It is easy to imagine that in real world the scale of the problems like these are much more huge and complex.*
- *There are plenty of similarities between the game session and the case text regarding the increased complexity...*
- *The second game session brought upon us several new features, though we were not yet totally familiar with the old features. As in the case text, we were too soon faced with too many new things. In any company you should first internalize the new processes before still new processes and systems are introduced. When you try to manage everything at the same time, the*

whole company may fall into chaos and eventually nobody can do anything or then you are dependent on some few people, as in the case text.

- *Actually, we faced exactly the same difficulties as the company in the case text.*

The huge majority of the answers present similar comments. The only comments stating different situation are from companies that decided to decrease game complexity by not starting the production of the new end product. Problems that were faced during the game and mentioned as realistic were: production capacity problems, increased delivery problems (order backlogs), running out of raw materials, problems in setting successful parameters for the automatic delivery system and/or the automatic material requirement system, and problems in estimating the future sales volumes. All answers included descriptions of some kind of problems that were similar to the case text. Several answers directly stated that the case and the game displayed surprisingly similar challenges.

The students often referred to the complexity of the game exercise. Although the students stated that managing all the different tasks in the simulation was very complex and demanding, they enjoyed the challenge in the experiment. This interpretation is further supported by the student answers (91 returned questionnaires in 2005) to the course feedback questionnaire question: What were your feelings after the game experience? There were 5 comments stating that the playing was some what confusing or just ok, and 7 students did not answer the question. The remaining 79 answers were extremely positive, describing the gaming experience as nice, interesting, challenging, and rewarding, creating immersion and the loss of the sense of time.

By explicitly stating facing similar problems as in a real world ERP implementation case the students are supposed to have faced learning which is more lasting and deeper than what could have been achieved just by reading the same case texts. The students have experienced experiential learning, learning through experimenting with decisions and then analysing the effects from these decisions. The problems faced in the simulation game often had a cause-effect relationship and separating the problems from each other caused some challenge in the analysis phase. What comes obvious, however, is that the students could easily perceive the correspondence of the simulation game and the real-world case in all of the areas described in the case text. How many of the challenges they faced depended on how they had decided to cope with the increased complexity. In 2005 five groups mentioned that they deliberately avoided selling and producing the new product, and that this helped them considerably in managing the complexity. These five groups mainly faced problems in estimating the demand or delivery problems. Many other groups stated that they had restricted the problem domain by leaving some areas out of their strategy (like the oldest product), leading to better grip on the remaining decision-making tasks.

Question 4: *How does the change in your own awareness of the challenges in the management of the materials process suite the case text? For example, were you able to take over the parameterization of the automatic raw material orders at once or did you face problems?* The parameterization in question dealt with setting re-order points for the automatic raw materials purchase system. This challenge in the simulation game and the question aimed at clarifying to the students how complex and demanding an ERP system parameterization task is. The students answered, for example, as follows:

- *Managing the materials process proved to be a very challenging process and the mistakes we made became very costly for our company.*
- *The management of the materials process succeeded well in the second game session. Each of the team members understood the benefits from the ERP and what you can achieve with it. Thus, it is not enough to have an ERP system, but it also needs to be tuned up suitable for the processes either by changing the application itself, supplementing the system with own in-house applications, or by using the flexibility of the ERP. Especially you need to consider the requirements of both inventories and production in each phase of the manufacturing process, from raw materials to end products.*
- *We learned to manage the materials process phase by phase through practise. We approached the whole process in several occasions through experimenting and by getting acquainted with the decisions we had done. For example, we had to consider and change the parameterization of the automatic orders a couple of times, and this way we approached the optimal values.*
- *...Towards the end our operations got better and perception on the management grew. It was good to see how demanding and accurate the inventory management can be and how “small” mistakes affect the whole – the production process.*
- *We started using the parameters right in the beginning of the second game session. But the parameters needed to be changed several times in the beginning, in order to find the optimal inventory size and re-order frequency, especially as we got new machinery and workers to the production process, as also in the case example. When we got the materials process under control in the end of the game we understood how crucial managing the process was for the success in the game, as also in the example.*
- *As problems arose in the materials process, the role of the ERP system was clearly emphasized. In the beginning the raw material purchases were considerably easier than in the first game session, but through mistaken implementation problems accumulated in the middle of the game. We had misunderstood the use of re-order points and order sizes with the*

consequence that Electronics inventory was at every turn finished although we thought that everything in the parameters was ok. After correcting the mistake we got the inventory situation to improve, but the game was then already in the end. The problem in the materials availability thus forced us to make acquaintance to the system even better. Overall we can say that during the game it became clear that why the materials process needs to function properly to avoid wastage and expensive raw material purchases.

Again the huge majority of the answers are extremely positive against gaming and the students were able to make a link between the simulation game and the case text. What is even more important is that the students understood the delicate nature of balancing a comprehensive materials process in a manufacturing organization. The students understood that wrong parameterization somewhere in the process leads to problems in the subsequent phases of the process. For us this indicates the very essential and important perception of the dynamics between different tasks and functions in a business organization.

Results

The student answers reveal that the use of the simulation game was able to deliver the business process perspective absolutely necessary for the understanding of the functioning of a modern enterprise information system. IS professionals and managers need to understand, for example, the different phases of an order-delivery process and how myriads of orders and deliveries cause problems, e.g., for the cash flow. These kinds of issues can very well be introduced with simulations. On the other hand, we doubt whether a detailed walk-through with a single transaction in an ERP system reveals anything about the systemic nature of the order-delivery process.

Secondly, simulation gaming as a learning method is motivating and perhaps raises less negative attitudes than hands-on ERP exercises. This can be explained with the findings of Leidner and Jarvenpaa (1993), who note that the most preferred methods for computer-based learning are those that (1) give the students interactive use of computers and (2) allow the students to work independently of the instructor on the computer to encounter their own problems in a classroom environment. The interactive use of an ERP system in a class environment is very challenging.

But what is the relevance of our course case in relation to the issues introduced in Section Potential ERP Systems Education Pitfalls of this paper? We will now go through the potential pitfalls one by one. **First** of all, when using lighter tools than the actual ERP software, the universities are less bound to certain software products. This leads to freedom in selecting the most suitable and advanced tools for the purpose in question. There is no need for long-term plans and commitment

for heavy products that may become a burden – for example, when there are faculty changes – in the long term. The faculty is also able to develop the curriculum gradually, as the curriculum consists of many smaller learning modules and applications.

Second, using tools like the one applied in the teaching case of this paper gives the students a more general, top-level image of the application area of an ERP system, in a relatively short period of time. Forming the general view through the use of an full scale ERP systems required extensive familiarization to the system as the whole builds upon different very detailed software modules. We severely question the sensibility of sacrificing a considerable amount of the teaching resources and time to detailed lower level tasks and functionality of an ERP system as this comes with the cost of having fewer resources for the more general education necessary for present day Information Systems professionals. As we noted earlier, Lee et al. (1995) found out that among the highest rated skills of IS professionals in the future are: ability to learn about business functions, ability to interpret business problems and develop appropriate technical solutions, ability to understand the business environment, and knowledge of business functions. In our opinion none of these skills requires detailed and extensive hands on experience on the actual ERP systems. Surely the professionals need to understand the tasks carried out using ERP software, but this understanding should not require endless SAP hands on exercises. What is more important for IS professionals is to understand, for example, organizational issues and how different business disciplines function together and how the dynamic complexity of the business organization and its environment operates. As also noted earlier, we are convinced that the aim of building a general education will suffer if ERP teaching is given too much emphasis.

Third, as should be obvious, using substitutive learning tools saves money, that can more wisely be spend on other resources. It would be extremely important to get the universities to realize that there are alternatives for the huge ERP investments. Actually, it should be obvious that by renouncing from ERP application plans universities are more able to deliver education that answers to the needs of the future employers of their students. An issue related to this is that also the future employers should understand that hands-on experience on ERP systems is not the most important feature of their future IS managers, but the ability to solve problems and to understand the dynamics of the business organization and its environment. Only this kind of skills base can truly benefit the future employer. Here we want to note that the students often call for, e.g. SAP exercises, as they also think that their future employers request for hands-on experience on a certain ERP software.

As noted earlier, too often universities seem to think that they are obliged to purchase an ERP system for teaching purposes only because the other universities are doing the same thing. This seems to be the same pattern which has led to many

unstructured and poorly planned ERP system investments in companies. Universities which base their operations on scientific research should understand that decisions on this scale should be justified with research results supporting the investment.

Fourth, as we described earlier, it is difficult to produce a workable training environment in an ERP system environment; without them the school ERP system environment is not going to illuminate reality with full complexity and dynamicity.

Fifth, we also believe that the universities' task is to provide other kind of education than application hands-on training. This kind of training suites better to polytechnical universities which produce employees for the more operational level of organizational work. Also the curriculum of polytechnics gives more possibilities for hands-on type of teaching.

Conclusions

The basic message of this paper is that universities have alternatives for realizing ERP teaching within enterprise systems courses. We hope to have proven that lighter training systems are a notable alternative. What is, however, the clearest implication of this paper, is that the effectiveness, functionality and productivity of any ERP system as a learning environment needs critical examination. So far the academia has almost totally neglected to study this topic.

References

- Beatty, R. C. and Williams, C. D. (2006). ERP II: Best Practices for Successfully Implementing an ERP Upgrade. *Communications of the ACM*, vol. 49, no. 3, 105-109.
- Becerra-Fernandez, I., Murphy, K. E., and Simon, S. J. (2000). Integrating ERP in the Business School Curriculum. *Communications of the ACM*, vol. 43, no. 4, 39-41.
- Bingi, P., Sharma, M. K., and Godla, J. K. (1999). Critical Issues Affecting an ERP Implementation. *Information Systems Management*, vol. 16, no. 3, 7-14.
- Boersma and Kingma (2005). From means to ends: The transformation of ERP in a manufacturing company. *The Journal of Strategic Information Systems*, vol. 14, no. 2, 197-219
- Botta-Genoulaz, Millet and Grabot (2005). A survey on the recent research literature on ERP systems. *Computers in Industry*, vol. 56, no. 6, 510-522.
- Cannon, D. M., Klein, H. A., Koste, L. L., and Magal, S. R. (2004). Curriculum Integration Using Enterprise Resource Planning: An Integrative Case Approach. *Journal of Education for Business*, November/December 2004.
- Draijer, C. and Schenk, D. (2004). Best Practices of Business Simulation with SAP R/3. *Journal of Information Systems Education*, vol. 15, no. 3, 261-265.
- Gupta, J. N. D. and Wachter, R. M. (1998). A capstone course in the information systems curriculum. *International Journal of Information Management*, vol. 18, no. 6, 427-441.
- Hammer, M. (1996). *Beyond Reengineering*. Harper Business, New York.

- Johnson, T., Lorents, A. C., Morgan, J., & Ozmun, J. (2004). A Customized ERP/SAP Model for Curriculum Integration. *Journal of Information Systems Education*, vol. 15, no. 3, 245-253.
- Kumar, M. and Kumar (2003). An investigation of critical management issues in ERP implementation: empirical evidence from Canadian organizations. *Technovation*, vol. 23, no. 10, 793-807.
- Lainema, T. (2007, forthcoming). Open System View Applied in Business Simulation Gaming. *International Journal of Advanced Technology for Learning on Games-based Learning*, Summer 2007.
- Lainema, T. and Nurmi, S. (2006). Applying an Authentic, Dynamic Learning Environment in Real World Business. *Computers and Education*, vol. 47, no. 1, 94-115.
- Lee, D., Trauth, E. M., and Farwell, D. (1995). Critical skills and knowledge requirements of IS professionals: A joint academic/industry investigation. *MIS Quarterly*, vol. 19, no. 3, 313-340.
- Leidner, D., and Jarvenpaa, S. (1993). The information age confronts education: Case studies on electronic classrooms. *Information Systems Research*, vol. 4, no. 1, 24-54.
- Rajagopal, P., and Tyler, F. (2000). Enhancing Manufacturing Performance with ERP Systems. *Information Systems Management*, vol. 17, no. 3, 43-55.
- Saccomano, A. (1998). More than Manufacturing. *Traffic World*, vol. 256, no. 5, 46.
- Sein, M., Bostrum, R., and Olfman, L. (1999). Rethinking End-User Training Strategy: Applying a Hierarchical Knowledge-Level Model. *Journal of End User Computing*, vol. 11, no. 1, 32-44.
- Shtub, A. (2001). A Framework for Teaching and Training in the Enterprise Resource Planning (ERP) Era. *International Journal of Production Research*, vol. 39, no. 3, 567-576.
- Trauth, E. M., Farwell, D., and Lee, D. (1993). The IS expectation gap: Industry expectations versus academic preparation. *MIS Quarterly*, September, 293-307.

Towards a Contingency Framework for Engineering an Enterprise Architecture Planning Method

Mauri Leppänen

Computer Science and Information Systems
University of Jyväskylä
mauri@cs.jyu.fi

Katariina Valtonen

Information Technology Research Institute
University of Jyväskylä
katariina.valtonen@titu.jyu.fi

Mirja Pulkkinen

Information Technology Research Institute
University of Jyväskylä
mirja.pulkkinen@titu.jyu.fi

Abstract. Enterprise architecture (EA) has a key role in managing and relating business strategies and processes, information systems, and IC technologies. EA planning devises an EA plan with development steps to make necessary enhancements to the current state of the affairs in EA. Accomplishing EA planning in a systematic and efficient manner requires the availability of frameworks and methods suitable to the situation at hand. The selection and adaptation of these methodical artifacts for the use of EA planning is often quite challenging in practice. We argue that the contingency approach can help in these activities of method engineering (ME), and present a contingency framework (named here EACon, EA Contingencies) for engineering an EA planning method. The framework is composed of three layers: the topmost layer pertains to a method engineering context, the next lower layer corresponds to an EA planning context, and the lowest layer stands for an EA development context. Due to the largeness of the framework, this paper focuses on the topmost layer. The contingency framework has been derived from ISD contingency factors, conceptualizations of the ME domain, EA critical success factors, and experience obtained from a large national project of engineering an EA planning method for state administration.

Keywords. Contingency Framework, Enterprise Architecture (EA), EA Planning, EA Development, Method Engineering, EA Method Engineering.

Introduction

In the past few years enterprise architecture has become an increasingly important means to cope with the complexity faced in managing business strategies and processes, information processing and IC technologies. *Enterprise architecture* (EA) is seen as a collection of artifacts that define and describe the structure and processes of an enterprise (a private company or public organization), the information being stored, processed and communicated in this enterprise, the systems used for these activities, and the technologies and infrastructure that the systems are implemented with. These descriptions can take various forms, such as models, figures, tables, matrices and textual representations. *Enterprise architecture planning* stands for the activities that aim at improving the current state, in other words devising development steps to make enhancements to the present ICT infrastructure, systems, information management and also the organizational processes and structures. This emphasizes the simultaneous development of the business and organizational activities, on one hand, and the ICT systems and architectures, on the other hand (Applegate 1994). *EA development* means the realization of an EA plan, or part thereof, in some organizational unit(s). EA development is an effort limited in scope and time, typically conducted as projects either by the end-user organization IT function or by an ICT provider (Pulkkinen and Hirvonen 2005b).

Several frameworks, models and methods have been suggested for the EA planning and development (e.g. see reviews e.g. Whitman et al. 2001, Schekkerman 2003, Pulkkinen and Hirvonen 2005a). The Open Group Architecture Framework, TOGAF, version 8, “Enterprise Edition” together with the Architecture Development Method (ADM) collects the best practices from a large number of efforts, among the most influential ones being the US Federal Government Enterprise Architecture Framework (FEAF) and domain specific frameworks that were created for different government sectors (The Open Group 2003). Situations in EA planning differ greatly from one another, implying that there is a need to carefully consider which kinds of strategies, approaches, frameworks and methods should be applied in each of them. The EA field is evolving rapidly, and hence new methodical artifacts and new variants of the existing ones are needed. Due to the novelty of the EA field, engineering these methodical artifacts is quite challenging. To support the selection, construction and customization of methodical artifacts for EA planning, some kind of contingency framework would be of great help. There are some lists of success factors for EA planning (e.g., Ylimäki 2006), but, as far as we know, no contingency frameworks are available.

Method engineering (ME) means all kinds of actions by which a new method, or an improved method, is developed, customized and configured to fit the needs of a domain, an organization or a project (Leppänen 2005). The ME literature

suggests a number of strategies, meta models, techniques and procedures to support this engineering work (e.g. Kumar et al. 1992, Harmsen 1997, Tolvanen 1998, Ralyte et al. 2003, Kelly et al. 1996, Leppänen 2005). Although these artifacts have been originally crafted for the use of engineering information systems development (ISD) methods, they are, to some extent, applicable to EA method engineering as well. Contingency frameworks have been commonly deployed in ISD (e.g. van Slooten et al. 1996, van Offenbeek et al. 1996, Kettinger et al. 1997, Hardgrave et al. 1999, Backlund 2002), but no frameworks are available for ME, and even less for EA ME.

This paper suggests a contingency framework, called the EACon framework, for engineering an EA planning method. This framework is composed of three layers: the topmost layer pertains to a method engineering context, the next lower layer corresponds to an EA planning context, and the lowest layer stands for an EA development context. Due to the largeness and complexity of the framework, this paper focuses on the topmost layer. The construction of the contingency framework has followed three strategies. First, based on a certain kind of analogy between EA planning and ISD, we have derived contingency factors from those suggested in ME and ISD literature. Second, we have utilized the literature on critical success factors of EA planning (e.g. Ylimäki 2006) to find out which of aspects in EA planning are crucial. Third, we have exploited our experience from a large national project of engineering an EA planning method for state administration.

The remainder of the paper is organized as follows. First, we shortly discuss EA, method engineering and contingency approach. Second, we describe the research framework and process. Third, we present contingency factors of the topmost layer for EA planning method engineering. The paper ends with the summary and conclusions.

Basic Concepts

Enterprise Architecture and its Planning

Enterprise architecture involves both enterprise management through the management of its ICT support, and the development and maintenance of the information systems in use in the enterprise. *Enterprise* (The Open Group 2003) means an organized group of people working towards a common goal such as production of products or services, and may mean either a commercial or public organization. *Architecture* (O'Rourke et al. 2003) is commonly understood as the description of a structure, its parts and their interdependencies. The dual reference to the enterprise and its information systems is captured in the definition:

"Enterprise architecture (EA) identifies the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization. The components include staff, business processes, technology, information, financial and other resources, etc. Enterprise architecting is the set of processes, tools, and structures necessary to implement an enterprise-wide coherent and consistent IT architecture for supporting the enterprise's business operations. It takes a holistic view of the enterprise's IT resources rather than an application-by-application view." (Kaisler et al., 2005).

Comprehensive architectures can be described only taking different viewpoints (Zachman 1987) that enable the consideration of an aspect in detail by excluding other aspects. All viewpoints together constitute the architecture. The enterprise architecture viewpoints that are generally chosen for EA methods are business, information, systems and technology (NIST/Fong and Goldfine 1989, Armour et al. 1999, Hasselbring 2000, The Open Group 2003, Perks and Beveridge 2003). These viewpoints are also found in several commercial EA methods (e.g. META Group 2002), and usually they are called Business Architecture (BA), Information Architecture (IA), Systems or Applications Architecture (SA) and Technology Architecture (TA).

Business architecture means the descriptions of the organization of the business: the business processes, structures and services. *Information architecture* depicts the information model and flows of information within the enterprise at a high abstraction level. To detect business potential of information, sometimes the concept of information value chain is used. *Systems architecture* stands for the portfolio of applications in use in an enterprise and the interconnections between the applications. These can be concretized in information systems architecture diagrams or integration architecture descriptions. *Technology architecture* consists of technologies including software, hardware and data communication connections..

The set of four architectural viewpoints meets both the needs of EA management, and the planning and development projects targeting the modification or enhancement of the current EA structures. EA planning has its roots in the concept of information systems planning (Olle et al. 1988) meaning a phase of comprehensive planning of the enterprise systems prior to a development project of a system. With today's integrated and interdependent information processing infrastructures, an architectural approach is needed instead of considering isolated systems and their development schedules. From early on, the idea of different abstraction levels was found necessary in EA planning (Zachman 1987). Based on studies of practical EA work, three levels were found necessary in EA planning cases for different decision making levels in the enterprise (Hirvonen and Pulkkinen 2004, Pulkkinen and Hirvonen 2005a). The business decisions and the overall information management decisions come from the top managerial level and the strategy process concerning the whole enterprise, thus

called the enterprise level. However, for more concrete practical planning, considering different domains within the enterprise is undertaken at the domain level. Since the EA development in practice can only be done incrementally, the enterprise is divided for planning and development purposes into domains with closely related information processing needs. A business unit can be a domain, or a cross-organizational business process (The Open Group 2003). Whereas at the *enterprise level*, EA principles and guidelines are outlined for the whole enterprise, at the *domain level*, practicable plans are made in the forms of business process definitions, information models, divisions into information storages, information systems deployment plans to technology infrastructures, integration architectures etc. At the third and most concrete level, the *systems level*, the plans are translated to systems design descriptions and further refined with systems development guidelines (Hirvonen and Pulkkinen 2004).

An example illustrates the treatment of a viewpoint, business architecture: at the enterprise level, the core business processes and the support processes are outlined as a coarse grained chart. The domain level description defines each process at the level of the business operations. The systems level description of a process guides the development of a supporting system for this process. The business architecture view at systems level means the business requirements for the systems to be developed. In one enterprise, the enterprise level architecture descriptions are binding for the whole enterprise. There are parallel domains, and the enterprise level EA work means also the coordination of the possibly concurrent planning and development efforts in different domains. Similarly, the systems level EA work means coordinating the development efforts with any system in the enterprise (Pulkkinen 2006).

A large number of frameworks, models, methods and processes have been suggested for the EA related work (Pulkkinen and Hirvonen 2005a). The earlier frameworks are consistent with the so-called waterfall model of information systems development, where the business needs come first, the logical structures are planned then and only at the final phases, the technological implementation takes shape. However, today the activities of any organization are to such an extent dependent on information systems, that the enabling IC technologies as well as the systems currently in use have to be considered already in the initial planning phases and together with the strategic business development plans. Thus, the *EA planning* is a demanding collaborative effort where the current state of the EA (i.e. the comprehensive ICT systems and infrastructure) and the business development visions are considered together. Among other business environment factors, the new technologies as possible business enablers are taken into account. For the domain and the systems level, the planning means materializing the strategic enterprise level decisions with concrete, practicable business and systems development plans. Often alternative plans are made, and

planning projects deliver also evaluations of e.g. applicability and cost of different solutions and technologies, the business implications etc.

EA development may follow the planning effort, however, most commonly as a separate project after one of the alternative plans is chosen. In a development project, detailed architecture is designed for at least one domain, and preparations are made for system implementation or integration, meaning either launching a systems development project or an integration project.

Method Engineering

A *method* means generally a collection of approaches, beliefs, principles, models, techniques and procedures to carry out a development effort. It is some kind of carrier of collective knowledge and experience that are made 'visible' in order to enable its exploitation and advancement in forthcoming situations (Tolvanen 1998, Fitzgerald et al. 2002). Methods carry four kinds of knowledge (Leppänen 2005): knowledge of development process, knowledge of application domain, knowledge of IC technology, and knowledge of human and social issues. We can distinguish between four types of methods depending on how generic or specific is the knowledge on development they contain: generic methods, domain-specific methods, organization-specific methods, and project-specific methods. *Generic methods* provide general support for development endeavors in a wide range of contexts. *Domain-specific methods* offer more special support in particular domains. *Organization-specific* and *project-specific methods* provide customized support for a specific organization or project, correspondingly.

For software engineering (SE) and information systems development (ISD), a multitude of methods have been constructed since the 1960's. Recently, special methods have been engineered for particular domains such as BPR, ERP, CRM and EAP. Yet more methods are needed due to changes in business and its environment, application areas, and approaches and technologies of development environments. Constructing a new method is not a simple task. It comprises the elicitation and analysis of requirements for a new method, the evaluation of current method(s), and the design and implementation of a new method, as well as the assessment of the method under engineering in each of the stages. We use the term '*method engineering*' (ME) to stand for all those actions by which an ISD method is developed and later customized and configured to fit the needs of a domain, an organization or a project (Leppänen 2005).

We distinguish between three main strategies of ME: creation from scratch, integration and adaptation. *Creation from scratch* is applied when no existing methods is suitable. *Integration* implies that a new method is engineered through assembling parts, called method components (e.g. Gupta et al. 2001, Leppänen 2005) or method fragments (e.g. Brinkkemper et al. 1999, Ralyte et al. 2003), from other methods. *Adaptation* is deployed when some method is available for the customization for the needs of an organization or a project, by dropping off or

modifying some parts of it, or extending it with new parts (Ralyte et al. 2003, Karlsson et al. 2004). ME approaches can be categorized, for instance, based on the degree to which practical and theoretical knowledge is applied (e.g. consultancy approach, method engineering approach and system development research in (Kaasboll & Smordahl 1996); deductive approach and inductive approach in (Fitzgerald et al. 2003)), or how urgently a new method is wanted into use (e.g. “typical” approach with pilot projects, “fast” approach with greater risks in Kruchten 2000).

The ME literature suggests a large variety of strategies and approaches (Kumar et al. 1992, Ralyte et al. 2003, Harmsen 1997), meta models (Heym et al. 1992, Kelly et al. 1996, Jarke et al. 1995), techniques (e.g. Kinnunen et al. 1996, Saeki 2003, Domingues et al. 2007) and procedures (e.g. Song 1997, Harmsen 1997, Tolvanen 1998, Leppänen 2005) for the engineering of ISD methods. Most of these suggestions are general-purpose and applicable to engineering methodical artifacts in other domains as well. Regardless of what strategy or approach is applied, the selection of ME artifacts and their customization are highly based on the recognition of and reasoning from essential features of the ME situation at hand, as well as the features of those contexts, called the target ISD contexts, for which a method is to be engineered. This is considered in more detail in the next section.

Contingency Approach

Contingency approach is based on the idea according to which there is no universal ‘solution pattern’ that would fit every problem situation. Instead, there is a need to select a pattern which has the best fit with the situation at hand. For this purpose, *contingency factors*, or situational factors, are used to characterize the situation and match them with the properties of the patterns. The contingency approach has been first applied in organizational design (e.g. Galbraith 1977, Pfeffer 1982, Kast et al. 1981, Drazin et al. 1985). In ISD, some of the first suggestions for contingency factors were presented by Naumann & Davis (1978), McFarlan (1981), Davies (1982), Iivari (1983) and Burns et al. (1985). Later, a large array of contingency frameworks (e.g. van Slooten et al. 1996, van Offenbeek et al. 1996, Kettinger et al. 1997, Fitzgerald et al. 1999, Hardgrave et al. 1999, Backlund 2002, Mirbel et al. 2006, Iivari et al. 2007) has been proposed to support the selection and construction of ISD approaches, models, techniques and methods. There are also different ways (e.g. Zhu 2002) and procedures (e.g. van Offenbeek et al. 1996) of applying the contingency approach. Regardless of some critics against the contingency approach (e.g. Lyytinen 1986, Avison et al. 1991, van Slooten et al. 1994, Avison 1996) it is widely applied in a number of fields.

The contingency factors in the ISD field are related to those aspects of an ISD project and its environment, which are seen important to making decisions on

which kind of ISD approach is selected, which kinds of models are deployed, how the ISD process is structured, and how end users participate in the process. Typically factors include, for example, management commitment; size, and complexity of a project; availability, clarity and stability of goals; motivation, skills and experience of stakeholders, and business and technology innovativeness. We have constructed an integrative view of ISD contingency factors given in literature and present it in a structured form in Appendix 1. It goes beyond this paper to discuss them here.

The ME literature does not suggest any contingency frameworks for supporting decisions in method engineering. However, there are conceptual foundations with concept categories (e.g. Harmsen 1997, Leppänen 2005) and descriptions of ME projects in practice (e.g. Alderson et al. 1998, Fitzgerald et al. 2003, Karlsson et al. 2004) which can be used to elicit characterizing factors. In addition, based on the perceived analogy between ISD and ME (e.g. Olle et al. 1988, Kumar et al. 1992) we can derive ME contingency factors from those defined for ISD. Resulting from the latter, we can recognize generic contingency factors such as commitment of management, motivation, skills and experience of ME stakeholders, size and complexity of an ME effort etc. Of course, there are also factors that are specific to ME, such as level of generality and desired lifecycle of the method under engineering.

Research Framework and Process

This study aims to derive a preliminary set of contingency factors to be applied in the engineering of EA planning methods. These contingency factors refer to features of EA method engineering that have affects upon decisions on which kinds of ME approaches, ME principles, ME procedures and EA frameworks should be applied in a particular EA ME situation (shortly EA ME). In order to have a full support for these decisions, it is, naturally, necessary that ME artifacts are equally characterized with properties which can be matched with the contingency factors, and that there are empirical evidence on certain fits between the properties of ME artifacts and the contingency factors. The discussion of the properties of the ME artifacts and the 'fits' goes beyond this study.

Contingency factors can be derived in two manners, inductively and deductively. The former means that ME situations in practice are analyzed to find out which kinds of features of the situations are determinant in making decisions on approaches, principles, frameworks, and procedures. The latter implies that contingency factors are derived from existing literature. This literature covers proposed contingency frameworks, conceptual works and descriptive case studies. This study applies both of these manners, as shown in our design-theoretical research framework (cf. Hevner et al. 2004) in Figure 1. The contingency framework produced stands for a design artifact in the terminology

of Hevner et al. (2002). It is composed of three layers. The topmost layer, shortly EAP ME, corresponds to a situation where a method for EA planning is engineered. The next lower layer (EAP) stands for a situation where an EA plan is produced. The lowest layer means the realization of an EA plan, or a part thereof. This study covers the topmost layer.

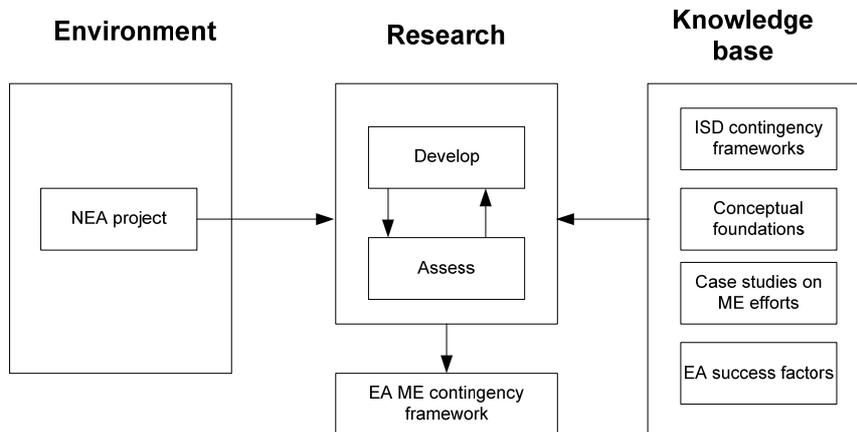


Figure 1. Research Framework

Knowledge base contains literature on ISD contingencies, conceptualizations of the ME and EA domains, descriptions of ME efforts in practice, and EA critical success factors. The research process has progressed as follows. Since the literature does not provide any contingency factors for EAP, not to mention for EAP ME, we paid attention to those ISD contingency factors that are generic enough to apply to EAP. The rationale behind this is that there is, on general level, an analogy between ISD and EAP situations. Second, we fleshed out the set of contingency factors with characteristics underlying suggestions for critical success factors for EA. Third, we derived from and compared to experience obtained in a large EA ME project, i.e., the Finnish *National Enterprise Architecture (NEA) project*. The project has involved a large number of representatives of state administration, consultancies and vendors. One of the subprojects of the NEA project has been aiming to engineer a generic EA method for state administration in Finland. Thus far, the first version of the EA method is under testing. One of the authors has participated as an active observer in workshops which evaluated existing methods and engineered a new one by integrating and adapting some of the selected methods. Also another subproject crafting the EA Capability Maturity Model (EACMM 2007) has affected the EACon framework constructed in this study. The more general mission of the NEA project is to advance the development of the public administration and its abilities to provide customer-oriented and flexible services and to increase the productivity of service production.

EACon framework - Contingency factors of EA Method Engineering

In this section, we first present a conceptualization of EA method engineering (EA ME) on a general level and then bring out potential contingency factors organized in accordance with this ontological structure (see Figure 2).

An *EA ME endeavor* means an effort to produce a new or an improved *EA method*. It can be organized as a project, or as a more or less non-structured action. It involves a single *enterprise* or a cluster of enterprises, which can be commercial or public organizations. A *cluster* is established around the endeavor, for instance, to create new networked services among them. The ME endeavor may deploy any variation of ME strategies and processes, e.g., construction of a generic EA method, EA method adaptation for a specific situation, situational EA method selection or modular method construction.

The EA ME endeavor is guided by *EA method goals* that are derived from requirements reflecting the views and needs of the members of the cluster. Reaching the goals requires the availability of *resources* including money, manpower, locations etc. The EA ME endeavor is constrained and directed by *EA principles* pertaining to architectural standards and decisions made in the organizations (Janssen and Hjort-Madsen 2007). Potential differences between local principles among members should be recognized and harmonized to yield a shared collection.

Some enterprises may have EA management of their own as a part of the strategy processes of the organizations. *EA management* targets the future strengthening and success of the enterprises (Pulkkinen and Hirvonen 2005b, Pulkkinen 2006). In the ME endeavor, the EA management of all the involved enterprises should be reconsidered in order to achieve a shared understanding of the future EA management. EA governance, in turn, is the annual process of maintenance (Jansen and Hjort-Madsen 2007) that supports the day-to-day operations and provide information for the strategic planning and management of the EA (Pulkkinen and Hirvonen 2005b).

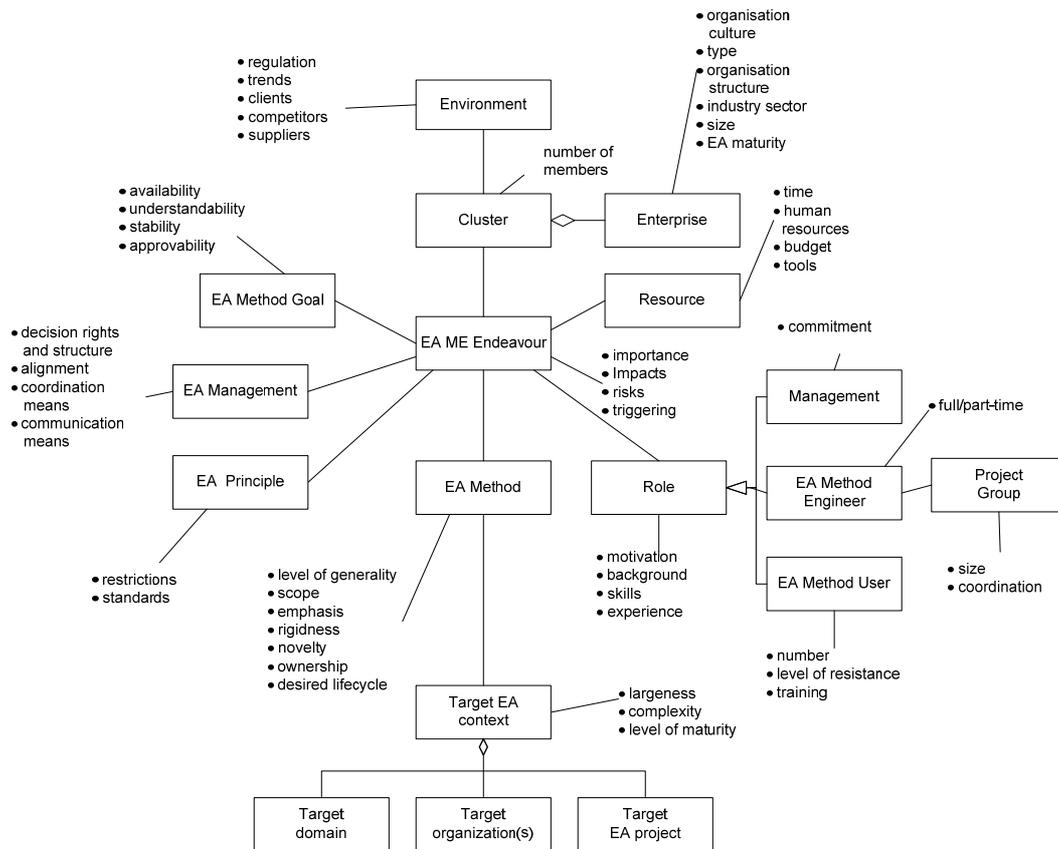


Figure 2. Contingency framework of enterprise architecture method engineering (EA ME).

An EA ME endeavor involves a number of persons in different *roles*. The typical roles in the EA ME are those of management, an EA method engineer and an EA method user. *Management* means here a role person who is in charge of making decisions on the launching the endeavor, allocating resources and approving the outcomes. Persons in this role may be representatives of top management, IT management or operational management. An *EA method engineer* stands for a role person who is engaged in selecting, analyzing, designing and implementing an EA method. The role can be played by an enterprise architect, a vendor or a consultant, each of them equipped with necessary expertise in business, information systems, ICT, ME tools, and/or EA methods. An *EA method user* means a role person who will deploy the EA method under engineering in forthcoming EA planning efforts. If engineering work is carried out in an organized form, a specific *project group* is established to include persons in the aforementioned roles. The EA method under engineering is targeted at some context, called the *target EA context* which is determined by a certain kind of domain, organizations, and EA planning projects, depending on whether the EA method is domain-specific, organization-specific or project-specific.

Next, we introduce contingency factors which can be used to characterize EA ME endeavors.

Characteristics of the enterprises in the cluster are organizational culture, type, organizational structure, industry sector, size, and EA maturity. *Organizational culture* is reflected by management structure and ways of making decisions (cf. Iivari and Huisman, 2007) and is manifested, for instance, as certain attitudes towards changes and ways of communication (Ylimäki 2006). *Type* means business, public administration or the third sector (Janssen & Hjort-Madsen 2007). *Organization structure* may, at its worst, reflect, e.g., silo thinking and strict profit responsibilities of an organization which can cause barriers to EA success (Ylimäki 2006). *EA maturity* means the awareness of, the attitudes toward, and the abilities to the management and development of EA in parallel to business management. EA maturity is seen, for instance, in how organization strategy and IT strategy are aligned (Hirvonen & Pulkkinen 2004, Ylimäki 2006).

EA management, and EA governance as a part of it, can be characterized by e.g. decision rights and structure (Janssen & Hjort-Madsen 2007), alignment (e.g. funding process), and communication and coordination means (Ylimäki 2006). *Decision rights and structure* includes the EA governance process, its roles, tasks, responsibilities and authorizations (Ylimäki 2006). From the EA ME viewpoint, the decision rights and structure tell who budgets the EA ME endeavor and who makes the final decisions about it. *Alignment* means the extent to which EA governance is integrated with Business Management Process, such as investment process or strategy refinement process (Ylimäki 2006). *Communication and coordination* are crucial for EA planning and governance (EACMM 2007), since the goal is to align large strategic entities in the enterprises, which requires intrinsic internal communication. Which kinds of communication channels are available, whether a common language including key concepts is defined (Ylimäki 2006, EACMM 2007), and whether coordination tools such as groupware and shared working places are in use affect on how an EA ME endeavor can be accomplished.

EA work is affected by many regulations and standards, which should be taken into account in engineering an EA method. *Regulation* include e.g. legislation, EU directives (IDABC 2004), national restrictions and agreements (e.g. Juhta 2007) and requirements for compatibility with other international or national models and instructions (EACMM 2007, Ylimäki 2006). *Restrictions* include, e.g., enterprise level architectural decisions, reference and model architectures to cope or follow (EACMM 2007). Reference architectures, for instance, may dictate how to view and act if interoperability between the target domain and that of the reference domains is demanded. *Standards* can be organizational or inter-organizational, and they can pertain to standard business processes, standard technical building blocks, or interfaces and interactions patterns (Janssen and Hjort-Madsen 2007).

The EA ME endeavors differ from each other in terms of their importance, impacts and risks, as well as why they are triggered. *Importance* means how far-reaching is it to have a new EA method. *Impacts* imply which (possibly) positive consequences result from using a new EA method. Every effort, including EA ME efforts, has some *risks* that should be recognized and taken into account (Ylimäki 2006). There are many kinds of reasons behind *triggering* an EA ME endeavor. There may be problems in EA planning and in the use of an EA method, and a new method is desired to solve these problems. Or a novel technology, a new application area, or a new approach to EA planning may require a new kind of methodical support.

Goals of the EA ME endeavors may diverge from one another in how *available, understandable, stable* and *approvable* they are, as well as what kinds of benefits are pursued. EA ME may appear to be an abstract entity for which it is difficult to set goals and express them in a way, which is understood by the stakeholders (cf. Ylimäki 2006). The larger the number of the involved stakeholders is, the more difficult it is to reach an agreement on the goals. Goals can be expressed in different ways, for instance, in terms of benefits to be reached or problems to be solved.

Success of any effort is dependent on the qualities of stakeholders participating in it. Attached to the notion of role we distinguish contingency factors such as *motivation, background, skills* and *experience*, related to EA, EA planning and EA method engineering. Particularly important is *commitment* of management on the EA ME endeavor. Also the degree of how intensively (i.e. full-time, part-time) stakeholders in their roles can contribute to the endeavor impact on the ways of working, organizing, controlling and coordinating EA ME. Resources are commonly measured in terms of *time, human resources* and money (*budget*). Other resources include *tools* and facilities, e.g. a shared dictionary, visualization techniques and tools (Janssen & Hjort-Madsen 2007),.

The EA method under engineering can be characterized by a level of generality, scope, emphasis, rigidity, novelty, ownership and desired lifecycle. A *level of generality* means the categorization into generic, domain-specific, organization-specific and project-specific EA methods. The *scope* and *emphasis* of the method can be expressed in terms of four architectural viewpoints (i.e. business, information, systems, and technology) and three levels (i.e. enterprise, domain, systems). *Rigidity* means how formally the models, techniques and process is to be specified in the EA method and how strictly they are to be followed in EA planning. *Novelty* refers to innovations expected to be in the EA method compared to existing methods. *Ownership* and *desired lifecycle* are important aspects in making decisions on the usage of ME resources.

Target EA context in Figure 2 is used to build a bridge to the EAP layer in the contingency framework. Factors related to it are general characterizations of aspects that are considered in more detail on the consequent EAP layer. Of the

large variety of aspects we only mention three, largeness, complexity, and level of maturity. *Largeness* and *complexity* are qualities for characterizing how large and complex are EA planning efforts that are to be prescribed by the EA method under engineering. *Level of maturity* refers to the degree to which EA planning related work is expected to be familiar in the target contexts.

Summary and Conclusions

This paper has presented a contingency framework, called the EACon framework, which is composed of factors for the characterization of a situation in which an enterprise architecture method is engineered. To construct the framework we first defined the basic concepts for enterprise architecture, method engineering and contingency approach. Contingency factors were derived from literature on ISD contingency factors, conceptualizations of EA and ME, case studies on method engineering, and EA critical success factors. We also deployed the experience obtained from a large project of engineering an EA method for state administration. The contingency framework is composed of three layers, of which we focused on the topmost layer pertaining to an EA ME situation.

The framework can be applied to support the selection and adaptation of EA method engineering strategies, approaches, models, techniques and ways of organizing an EA ME effort in a situational manner, as well as to carry out the retrospective analysis of accomplished EA ME efforts. For instance, the situation in the NEA project can be characterized by the following features: high importance of EA work to the interoperability of information systems of state administration; a large set of stakeholders on various administration levels; a need to have such a general-purpose method for EA domain, which could be later customized into organization-specific and EA project-specific methods; the absence of a suitable EA planning method. These situational features, among other things, affected that the EA ME endeavor was organized in the form of a specific project which involves a large number of representatives of state administration, applies a mixed ME strategy of integration and adaptation, and uses pilot projects to refine the method. Experience got this far from the project suggests that most essential contingency factors to be considered in the customization of the EA method for an organization are industry sector and EA maturity of the enterprise, scope and emphasis of the EA method, and skills and experience of EA method engineer and EA method users.

The results of this study are preliminary and the subject of the future research. First of all, the definitions of the current contingency factors should be elaborated by literature reviews and a more detailed analysis of the experience from practice. Second, the contingency framework should be extended to cover the two other layers concerning an EA planning situation and an EA development situation. Third, in order to fully utilize the EACon framework it is necessary to specify basic properties of EA ME artifacts and 'fits' with the contingency factors.

Fourth, the framework should be equipped with concrete instructions for how to deploy it in EA ME efforts in practice. Fifth, empirical studies in different fields are needed to validate the EACon framework.

Acknowledgements

One of the authors has been funded by Finnish Enterprise Architecture Research (FEAR) project, which is warmly thanked for.

References

- Alderson, A., Hull, M. E., Jackson, K., and Griffiths L. E. (1998). "Method engineering for industrial real-time and embedded systems". *Information and Software Technology*, 40, 443-454.
- Applegate, L. M. (1994). "Managing in an Information Age: Transforming the Organizations for the 1990's". In: R. Baskerville, S. Smithson, O. Ngwenyama and J.j. DeGross (eds.), *Transforming Organizations with Information Technology*. Elsevier Science B.V. / IFIP.
- Armour, F. J., Kaisler, S. H. and Liu, S. (1999). "Building an Enterprise Architecture Step by Step". *IT Pro Magazine*, July /August, 31-39, IEEE.
- Avison, D. (1996). "Information systems development methodologies: a broader perspective", In Brinkkemper J., Lyytinen K., Welke R. (eds.) *Principles of Method Construction and Tool Support*.
- Avison D., and Wood-Harper, A. (1991). "Information systems development research: an exploration of ideas in practice", *The Computer Journal*, 34(2), 98-112.
- Backlund, P. (2002). "Identifying situational factors for IS development processes: applying the method-in-action framework". In *Proc. of 8th Americas Conference on Information Systems*.
- Brinkkemper, S., Saeki, M. and Harmsen, F. (1999). "Meta-modelling based assembly techniques for situational method engineering". *Information Systems*. Vol. 24, No. 3, 209-228.
- Burns, R. N. and Dennis, A. R. (1985). "Selecting the appropriate application development methodology". *Data Base*, 17(1), 19-23.
- Davis, G. B. (1982). "Strategies for information requirements determination". *IBM Systems Journal*, 21(1), 4-30.
- Dominguez, E., Zapata, M. A. (2007). "Noesis: Towards a situational method engineering technique". *Information Systems* 32, 181-222.

- Drazin, R. and van de Ven, B. (1985). "Alternative forms of fit in contingency theories". *Administrative Science Quarterly*, Vol. 30, 514-539.
- EACMM 2007. Arkkitehtuurikyvykkyyden kypsyytasomalli. *Enterprise Architecture Capability Maturity Model. Instructions*. Version 0.81. 19.3.2007. Working Paper in Finnish, Finnish National EA Project.
- Fitzgerald, B. and Fitzgerald, G. (1999). "Categories and contexts of information systems developing: making sense of the mess". In *Proc. of European Conference on Information Systems*.
- Fitzgerald, B., Russo N. L. and O'Kane, T. (2003). "Software development method tailoring at Motorola". *Comm. of the ACM*, 46(4), 65-70.
- Fitzgerald, B., Russo, N. and Stolterman, E. (2002). *Information systems development – methods in action*. London: McGraw Hill.
- Fong, E. N. and Goldfine, A. H. (1989). *Information Management Directions: The Integration Challenge*. Special Publication 500-167. National Institute for Standards and Technology (NIST).
- Galbraith, J. (1977). *Designing complex organizations*. Addison-Wesley, Reading, MA.
- Gupta, D. and Prakash, N. (2001). "Engineering methods from method requirements specifications". *Requirements Engineering* 6(3), 135-160.
- Hardgrave, B. C., Wilson, R. L. and Eastman, K. (1999). "Towards a contingency model for selecting an information system prototyping strategy". *Journal of Management Information Systems*, 16(2), 113-136.
- Harmsen, F. (1997). *Situational method engineering*. Dissertation Thesis, University of Twente, Moret Ernst & Young Management Consultants, The Netherlands.
- Hasselbring, W. (2000). "Information System Integration." *Communications of the ACM* 43(6): 32-38.
- Hirvonen, A. and Pulkkinen M. (2004). "A Practical Approach to EA Planning and Development: the EA Management Grid". *Business Information Systems - BIS*, Poznan, Poland.
- Hevner, A., March, S., Park, J. and Ram, S. (2004). "Design science in information systems research". *MIS Quarterly*, Vol. 28, No. 1, 75-105.
- Heym, M. and Österle, H. (1992). "A reference model for information systems development". In K. Kendall, K. Lyytinen & J. DeGross (Eds.) *Proc. of Conf. on the Impacts on Computer Supported Technologies on Information Systems Development*. Amsterdam: Elsevier Science, 215-240.

- IDABC (2004). *European Interoperability Framework for pan-European eGovernment Services, version 1.0* [online]. <<http://europa.eu.int/idabc/en/document/3473/5585>>.
- Iivari, J. (1983). *Contributions to the theoretical foundations of systemeering research and the PISCO-model*, Dissertation Thesis, Acta Universitatis Ouluensis, Ser A 150, Institute of Data Processing, University of Oulu, Finland.
- Iivari, J. and Huisman, M. (2007). "The relationship between organizational culture and the deployment of systems development methodologies". *MIS Quarterly* 31(1), 35-58.
- Janssen, M. and Hjort-Madsen, K. (2007). "Analyzing Enterprise Architecture in National Governments: The cases of Denmark and the Netherlands". *Proceedings of the 40th Hawaii International Conference on System Sciences, HICSS 40*, Jan 3-6, Waikoloa, Big Island, Hawaii.
- Jarke, M., Gallensdörfer, R., Jeusfeld, M., Staudt, M. and Eherer, S. (1995). "ConceptBase: a deductive object base for meta data management". *Journal of Intelligent Information Systems*, Vol. 4, No. 2, 167-192.
- Juhta (2007). "JHS 145 Palvelutietojen ryhmittely ja osoitteet asiointia varten monta toimialaa kattavissa julkisen sektorin portaaleissa" [online]. *Public Administration ICT Recommendations in Finland (in Finnish)*, Juhta <<http://www.jhs-suositukset.fi/suomi/jhs145>>
- Kaasboll, J. and Smordal, O. (1996). "Human work as context for development of object-oriented modeling technique". In S. Brinkkemper, K. Lyytinen & R. Welke R. (Eds.) *Proc. of the IFIP TC8 WG 8.1/8.2 Working Conf. on Method Engineering: Principles of Method Construction and Tool Support*. London: Chapman & Hall, 111-125.
- Kaisler, S. H., F. J. Armour, et al. (2005). "Enterprise Architecting: Critical Problems". *Proceedings of the 38th Hawaii International Conference on System Sciences*, IEEE Computer Society.
- Karlsson, F. and Ågerfalk, P. J. (2004). "Method configuration: adapting to situational characteristics while creating reusable assets". *Information and Software Technology*, 46, 619-633.
- Kast, F. and Rosenzweig, A. (1981). *Organization and management: a system and contingency approach (3rd ed)*, McGraw-Hill, New York.
- Kelly, S., Lyytinen, K. and Rossi, M. (1996). "MetaEdit+: a fully configurable multi-user and multi-tool CASE and CAME environment". In Y. Vassiliou & J. Mylopoulos (Eds.) *Proc. of the 8th Conf. on Advanced Information Systems Engineering (CAiSE'96)*. Berlin: Springer, 1-21.

- Kumar, K., and Welke, R. (1992). "Methodology engineering: a proposal for situation specific methodology construction". In W. Kottermann & J. Senn (Eds.) *Challenges and Strategies for Research in Systems Development*. Chichester: John Wiley & Sons, 257-269.
- Kettinger, W., Teng, J. and Guha, S. (1997). „Business process change: a study of methodologies, techniques, and tools". *MIS Quarterly*, Vol. 21, No. 1, 55-80.
- Kinnunen, K. and Leppänen, M. (1996). "O/A matrix and a technique for methodology engineering". *Journal of Systems and Software* 33(2), 141-152.
- Kruchten, P. (2000). *The Rational Unified Process: An introduction*. Reading: Addison-Wesley.
- Leppänen, M. (2005). *An Ontological Framework and a Methodical Skeleton for Method Engineering*, Dissertation Thesis. Jyväskylä Studies in Computing 52, University of Jyväskylä, Finland.
- Lyytinen, K. (1986). *Information systems development as social action: framework and critical implications*. Dissertation thesis, Jyväskylä Studies in Computer Science, Economics and Statistics, University of Jyväskylä, Finland.
- McFarlan, F. W. (1981). "Portfolio approach to information systems", *Harwards Business Review*, 59(5), 142-150.
- METAGroup (2002). *Enterprise Architecture Desk Reference*, Meta Group Inc. National Association of State Chief Information Officers (Nascio). Enterprise Architecture Maturity Model. [cf. <http://www.nascio.org>]
- Mirbel, I. and Ralyte, J. (2006). "Situational method engineering: combining assembly-based and roadmap-driven approaches". *Requirements Engineering*, 11, 58-78.
- Naumann, J. D. and Davis, G. B. (1978). "A contingency theory to select an information requirements determination methodology", *In Proc. of the Second Software Life Cycle Management Workshop*, IEEE, New York, 63-65
- Offenbeek van, M. A. and Koopman, P. L. (1996). "Scenarios for system development: matching context and strategy". *Behaviour & Information Technology*, 15(4), 250-265.
- Olle, T., Hagelstein, J., MacDonald, I., Rolland, C., Sol, H., van Assche, F. and Verrijn-Stuart, A. (1988). *Information Systems Methodologies – A Framework for Understanding*. 2nd edition. Reading: Addison-Wesley.
- The Open Group 2003. *The Open Group Architecture Framework (TOGAF) Version 8.1 "Enterprise Edition"*. [online] on <<http://www.opengroup.org/togaf>>.
- O'Rourke, C., N., Fishman, et al. (2003). *Enterprise Architecture - Using the Zachman Framework*. Canada, Thomson Course Technology.

- Perks, C. and Beveridge T. (2003). *Guide to Enterprise IT Architecture*. New York, Springer.
- Pfeffer, M. (1982). *Organizations and organizations theory*. Ballinger Publ., Cambridge, Mass.
- Pulkkinen, M. (2006). "Systemic Management of Enterprise Architecture Decisions. Four Dimensions and Three Levels". *Proceedings of the 39th Hawaii International Conference on System Sciences*, IEEE Computer Society.
- Pulkkinen, M. and Hirvonen, A. (2005a). "EA Planning, Development and Management Process for Agile Enterprise Development". *Proceedings of the 38th Hawaii International Conference on System Sciences*, IEEE Computer Society.
- Pulkkinen, M. and Hirvonen, A. P. (2005b). "Organisational Organizational Processes in ICT Management and Evaluation. Experiences with Large Organizations" In: Remenyi, D. (ed.): *Proceeding of the 12th European Conference on Information Technology Evaluation (ECITE)*. Academic Conferences Limited 2005.
- Ralyte, J., Deneckere, R. and Rolland, C. (2003). "Towards a generic model for situational method engineering". In J. Eder & M. Missikoff (Eds.) *Proc. of the 15th Int. Conf. on Advanced Information Systems Engineering (CAiSE'03)*. LNCS 2681, Berlin: Springer-Verlag, 95-110.
- Saeki, M. (2003). "Embedding metrics into information systems development methods: an application of method engineering technique". In Eder J., Missikiff M. (Eds.) *Proc. of the 15th Intern. Conf. on Advanced Information Systems Engineering (CAiSE 2003)*, LNCS 2681, Springer-Verlag: Berlin, 374-389.
- Schekkerman J. (2003). *How to survive in the jungle of Enterprise Architecture Frameworks*. Creating or choosing an Enterprise Architecture Framework. Canada: Trafford.
- Slooten van, K., Brinkkemper, S. and Hoving, P. (1994). *Contingency-based situational systems development in large organizations*. Managing Social and Economic Change with Information Technology. Idea Group Publishing, Harrisburg.
- Slooten van, K. and Hodes, B. (1996). "Characterizing IS development projects". In: Brinkkemper S., Lyytinen K., Welke R. (eds) *Proc. of the IFIP WG 8.1 Conf. on Method Engineering – Principles of Method Construction and Tool Support*, Chapman & Hall, London, 29-44.
- Song, X. (1997). "Systematic integration of design methods". *IEEE Software*, Vol. 14, No. 2, 107-117.
- Tolvanen, J.-P. (1998).. *Incremental method engineering with modeling tools – Theoretical principles and empirical evidence*. Dissertation Thesis, Jyväskylä Studies in Computer Science, Economics and Statistics, No. 47, University of Jyväskylä, Finland

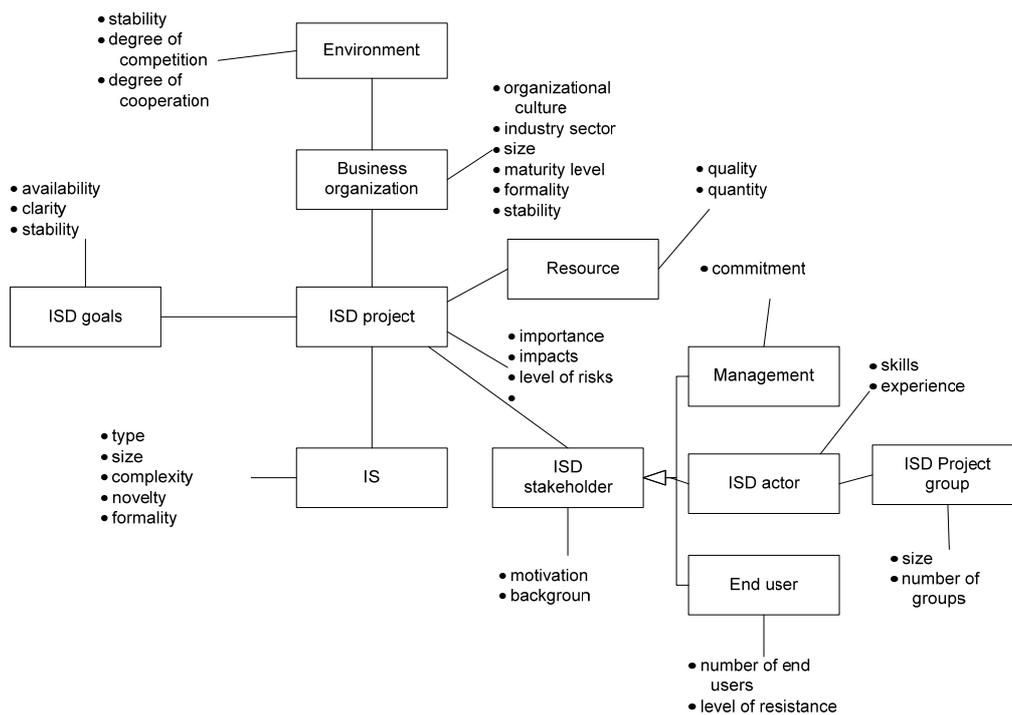
Whitman, L., K. and Ramachandran, et al. (2001). "A Taxonomy of a Living Model of the Enterprise". *Proceedings of the Winter Simulation Conference*, IEEE.

Ylimäki, T. (2006). "Potential critical success factors for enterprise architecture". *Journal of Enterprise Architecture* 2(4), 29-40.

Zachman, J. A. 1987. "A Framework for Information Systems Architecture." *IBM Systems Journal* 26(3).

Zhu, Z. (2002). "Evaluating contingency approaches to information systems design". *International Journal of Information Management*, 2.

Appendix 1



ISD contingency factors

The Adaptive Capability Lifecycle

Karin Fritzer

University of Oulu, Finland

karin.fritzer@oulu.fi

Abstract. In many industries apart from the software industry, software-enhanced products and services are becoming more and more important. The software proportion within those products and services is growing steadily, demanding the firms offering those products and services to get acquainted with a faster developing environment than they might be used to from their traditional business, calling for different organizational capabilities than those companies traditionally would need. The purpose of this paper is to introduce a model to research the development of organizational capabilities, both dynamic and operational ones, along their lifecycle in a systematic way. The model proposed in this paper is a combination of two already existing models: the capability lifecycle (Helfat and Peteraf, 2003) and the adaptive loop (Haeckel, 1995). The combination of those two models enables a systematic research of (dynamic) capabilities, helping reserachers to find out about differences in capabilities needed for operating in high-velocity markets as opposed to operating in moderately dynamic maerkets.

Keywords. dynamic capabilities, capability lifecycle, resource based view, software-enhanced business

Introduction

The purpose of this paper is to introduce a model for researching the development of (dynamic) capabilities. Additionally, the paper introduces the approach the author is pursuing in her Ph.D. thesis.

Software-enhanced businesses are becoming part of many industries which do not belong to the software industry. This development has become more and more obvious during the last decades, and software business in traditional industries is expected to become even more important during the years to come (Tyrväinen et

al., 2004). Software-enhanced business are businesses whose core business focus upon start-up was not on delivering products or services including software or being based on software, but whose products and services are becoming more and more dependent on software. Those software-enhanced companies develop at least part of the software contained in their products and services in-house. An example for a software-enhanced company would be the consulting company offering consulting services for the forest industry (presented in the empirical example later in this paper). The company started to develop software applications in the 1970ies in order to support its own internal processes which the company uses to offer its core services to the customers. By using in-house developed software for delivering its core offerings, the company became software-enhanced. A company being software-enhanced, however, does not necessarily carry out software business, but it can develop to that direction. The consulting company started to carry out also software business (after having become software-enhanced) by offering its software to external customers and by creating a software spin-off.

The software industry is known to be a fast-changing and fast-growing one (Wolter, 1996), whereas more traditional industries are in general not developing at an equally high pace as many of those industries have already reached a mature stage. While growth and development of the software industry as a whole are already widely researched, the growing importance of software to enhance products and services in companies outside the software industry has been neglected so far. One part aspect of a company's development is the development of its resources and capabilities. The resource based view and the capability approach were already formerly used to do empirical research in software and technology-based industries. Del Canto and González (1999) made a resource-based analysis of the factors determining a firm's R&D activities. Sallinen (2002) based the theoretical part of her Ph.D. thesis "Development of industrial software supplier firms in the ICT cluster" on the resource-based view and dynamic capabilities. Ethiraj et al. (2005) carried out a study about the importance of capabilities in the software services industry. Lee, Lee and Pennings (2001) investigated the effects of the internal capabilities and external network on the performance of technological start-ups. What is largely missing from scientific literature is research on resources and capabilities necessary for companies to succeed with their software-enhanced products and services.

Organizational capabilities can be divided into operational and dynamic capabilities. Operational capabilities produce an output or a good, whereas dynamic capabilities just indirectly contribute to the output through an impact on operational capabilities. An example of an operational capability would be the activity of developing a certain product (Helfat and Peteraf, 2003). Eisenhardt and Martin (2000) give examples of dynamic capabilities including the capability of strategic decision making, the capability to integrate and to reconfigure resources.

For the purpose of this paper, dynamic capability is defined as “the capability to reconfigure operational capabilities in response to changes in the environment”.

The (dynamic) capabilities of companies of traditional industries are developed to work in a slowly changing environment and therefore might not be suitable when getting involved with the much faster changing software business. This might affect the chances of software-enhanced companies to succeed in carrying out software-enhanced business and software business. It is important to know which factors are influencing on the decision of traditional companies to enhance their products and services with software, and how it affects the resources, including capabilities, of those companies and the industry in general, if the fast-developing software industry “meets” a company of an industry generally changing at a much slower pace. To be able to help software-enhanced companies to succeed with their software-enhanced products and services, it is necessary to know which resources are necessary for successfully conducting software-enhanced and software business, and how the existing resource and capability base of companies belonging to traditional industries is changing upon the company’s involvement with software business. Concerning the capability-part of resources, it is necessary to know which (dynamic) capabilities are missing from companies of traditional industries, which capabilities supporting the successful conduction of software business already exist in a software-enhanced company, and how already existing capabilities have to change in order to support successful conduction of software business. With this paper, the author suggests a way how to research the development of capabilities with help of Haeckel’s (1995) adaptive loop along Helfat and Peteraf’s (2003) capability lifecycle. This tool is not only suitable for researching the development of capabilities in software-enhanced companies, but for researching (dynamic) capabilities in general.

This paper first introduces the theoretical background for the model, then describes the principle of the adaptive loop along the capability lifecycle, describes the methodology of the planned empirical research, presents three examples of how the adaptive capability lifecycle can be used to research the development of two case company’s (dynamic) capabilities, and ends with a conclusion.

Theoretical background

The theoretical background of the research consists of the resource-based view of the firm (which the dynamic capability approach is based on), the capability approach and dynamic capability approach, and of the sense-and-respond approach. Together those theories, and especially Haeckel’s (1995) adaptive loop of the sense-and-respond approach and Helfat and Peteraf’s (2003) capability

lifecycle, build the basis for the adaptive capability lifecycle presented in this paper.

Resource-based view of the firm

The resource-based view has been first conceptualized by Penrose (1959) in ‘The theory of the growth of the firm’ and achieved wider recognition after Wernerfelt (1984) and Barney (1991) had published their articles on the resource-based view. The resource-based view explains the importance of resources for a company to gain sustained competitive advantage. The main points of this theory are to identify a firm’s potential key resources, evaluate whether these resources fulfil the criteria of being valuable, rare, imperfectly imitable and non-substitutable, and care for those resources that pass these evaluations as those are the resources enabling sustained competitive advantage. According to the definition of Barney (1991), p.101, ‘firm resources include all assets, **capabilities**, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness’. A firm achieves competitive advantage when it is able to implement a ‘value creating strategy not simultaneously being implemented by any current or potential competitor’ (Barney, 1991).

According to Barney (1991), not all business processes will be a source of competitive advantage for a firm. Resource-based logic suggests that business processes that exploit valuable, but common, resources can only be a source of competitive parity; business processes that exploit valuable and rare resources can be a source of temporary competitive advantage; and business processes that exploit valuable, rare and costly-to-imitate resources can be a source of sustained competitive advantage. In addition, to realize the full competitive potential of its resources and capabilities, a firm must organize its business processes efficiently and effectively (Barney and Wright, 1998).

The resource-based approach views the firm as a historically determined collection of assets or resources which are tied semi-permanently to the firm's management (Wernerfelt, 1984). Some users of the resource based view distinguish fully appropriable resources, such as physical capital or brand names, from less tangible asset, such as organizational routines and capabilities (Lockett and Thompson, 2001). According to Ray, Barney and Muhanna (2004), processes that exploit intangible resources (rather than tangible ones) are more likely to be a source of sustained competitive advantage.

Capability and dynamic capability approach

The capability approach is a stream within the resource-based research and helps to deepen the concepts of resources and capabilities and the process of transferring and imitating them both within and between firms. According to Foss

and Foss (2000), capabilities (competences, dynamic capabilities, higher-order organizing principles...) are meta-routines that represent a firm's capacity to sustain a coordinated deployment of routines in its business operations.

As the resource-based view does not explain how and why certain firms have competitive advantage in situations of rapid and unpredictable change, Teece, Pisano and Shuen (1997) have expanded the resource-based view to dynamic markets. Dynamic capabilities were first presented in form of a framework in their article "Dynamic capabilities and strategic management". They define dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments". The term "dynamic" refers to the capacity to renew competences so as to achieve congruency with the changing business environment. Markides and Williamson (1996) distinguish between strategic assets and competences, where competence is the know-how needed to build assets. This definition of competences goes along with Teece, Pisano and Shuen's (1997) definition of dynamic capabilities. Markides and Williamson (1996) also point out, that other authors refer to both strategic assets and competences as being resources (e.g. Barney, 1991). Eisenhardt and Martin (2000) define dynamic capabilities as

"the firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die."

Helfat and Peteraf (2003) pick up this definition of capabilities and dynamic capabilities as a set of routines. They distinguish two kinds of routines: those that perform individual tasks and those that coordinate the individual tasks. Eisenhardt and Martin (2000) distinguish between dynamic capabilities in moderately dynamic markets and dynamic capabilities in high-velocity markets. Dynamic capabilities in moderately dynamic markets resemble the traditional conception of routines, they are complicated, predictable and analytic processes that rely extensively on existing knowledge, have a linear execution and slow evolution over time. Dynamic capabilities in high-velocity markets are simple (not complicated), experimental (not analytic), and iterative (non-linear). They are difficult to sustain. This suggests that dynamic capabilities needed for successfully conducting software-enhanced business and software business differ from dynamic capabilities needed for successfully operating in slower changing industries.

Helfat and Peteraf (2003) developed a dynamic resource based view and introduced the **capability lifecycle**, valid both for operational and dynamic capabilities. Operational capabilities produce an output or a good, whereas dynamic capabilities don't directly affect the output of the firm in which they reside, but indirectly contribute to the output of the firm through an impact on operational capabilities. An operational capability generally involves performing an activity, such as manufacturing a particular product. Within this process, a

collection of routines is used to execute and coordinate the different tasks needed to perform the activity. The capability lifecycle depicts the evolution of an organizational capability that resides within a team. In their initial capability life cycle, where initial refers to capabilities that did not exist before in a company and are built from scratch, Helfat and Peteraf (2003) recognize three stages. The founding stage lays the basis for the subsequent development of the capability. It is followed by the development stage, which is marked by gradual building of the capability. Eventually, capability building ceases and the capability reaches the maturity stage. Sometimes, factors external to the capability have a strong enough impact on the capability to alter its current development trajectory, which is called capability branching. Those so-called selection events can derive from within the organization (internal selection environment) or from outside (external selection environment) including changes in demand, science and technology and the availability of raw materials. Some selection events may reinforce the current trajectory of a capability along its lifecycle rather than lead to branching.

Helfat and Peteraf (2003) identify six branches the capability can go after occurrence of a selection event (see Figure 1), the “six Rs of capability transformation”, namely *renewal*, *redeployment*, *recombination* (their level of capability per unit of activity begins at or below the capability’s previous level), *replication* (may include a drop in the level of capability), *retrenchment* (a gradual or discrete decline in the level of capability) and *retirement* (which means that the capability dies).

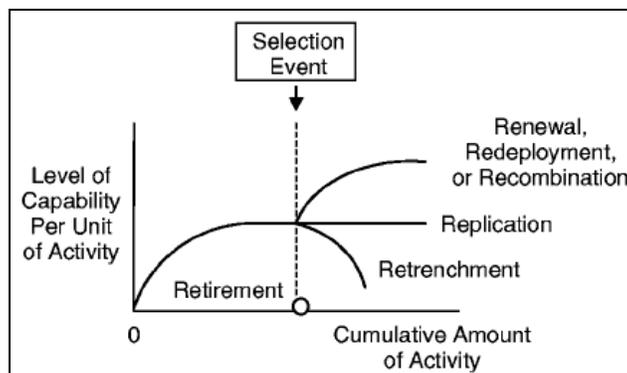


Figure 1. Branches of the capability lifecycle, Helfat and Peteraf (2003)

For the purpose of this paper, the dynamic capability definitions by Helfat and Peteraf (2003), by Eisenhardt and Martin (2000): “Dynamic capabilities allow firms to reconfigure capabilities in response to changing market conditions” and by Teece, Pisano and Shuen (1997) like already cited above, apply. Dynamic capabilities, therefore, are capabilities to reconfigure operational capabilities in response to changes in the environment.

Sense-and-respond approach

The sense-and-respond approach was introduced by Haeckel (1995) and is meant as a management tool for achieving competitive advantage in times of constant unpredictable change. In order to successfully use the sense-and-respond approach, corporations have to become constantly adapting organisms. Adaptive enterprise design as defined by Haeckel (1995) consists of four principles. First, the company has to design a firm-specific governance mechanism that coordinates and provides a context for business behaviour. A governance mechanism has three elements: a set of governing principles, a governance model, and a governance process. Second, the company has to incorporate personal accountabilities, as well as procedures, in the design of business processes. Third, the company has to design processes that make other processes learn. This principle includes the adaptive loop (Figure 2), which is a template for people to use in designing extremely change-sensitive processes with rapid response requirements. Fourth, the company has to design modular processes to be able to offer mass customization.

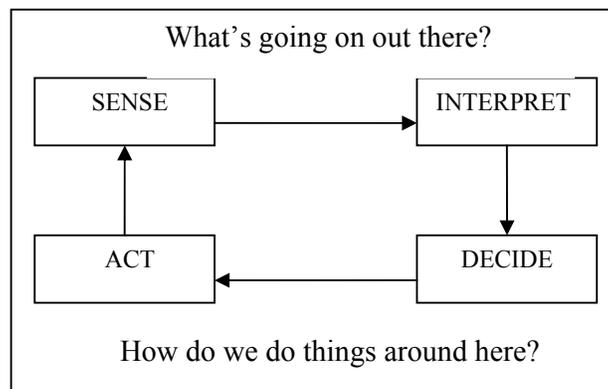


Figure 2. Adaptive loop, Haeckel (1995)

Mathiassen and Vainio (2005) used Haeckel's sense-and-respond approach as a lens to understand dynamic capabilities in small software firms. According to Haeckel (1999), adaptive enterprises are translating events in relation to the context of the event in cycles. Mathiassen and Vainio (2005) summarize the steps of this cycle as "organizations first sense changes in their environment. Next, they interpret these changes in the context of relevant experiences, aims, and capabilities, separating threats from opportunities and discarding irrelevant information. Then organizations decide if and how to respond, and, finally, they act." According to their case study, the sense-and-respond framework integrates activity- and firm-level dynamic capabilities related to input, process and output aspects of software development.

Arriving at the model

Intangible resources are, according to Ray, Barney and Muhanna (2004), rather a source of sustained competitive advantage than tangible ones. This suggests that research on a company's intangible resources, including competences and capabilities, is important to understand the implications for a software-enhanced company of a traditional industry on competitive advantage when getting involved with software business.

Peteraf and Bergen (2003) argue that it is possible to identify direct competitors by comparing their resources and capabilities, where capabilities should not be defined in terms of resource types, but in terms of the functions they serve. According to them, similarities among firm capabilities provide information about the potential of firms to produce similar products. This thought can be developed further: firms with similar capabilities in carrying out software business might have a similar potential of succeeding in software business. In order to help software-enhanced companies of traditional industries to have better chances in succeeding with software business, it is important to understand the capabilities of software companies concerning the functions those capabilities serve. Then it would be possible to compare those functions to the functions of capabilities in software-enhanced companies and in those carrying out software business of traditional industries, and to advise them how to develop their capabilities to make them better suitable for software-enhanced business and software business. In order to help those to develop their already existing capabilities further or to develop capabilities from scratch, it is necessary to understand the development of capabilities in a systematic way.

Helfat and Peteraf (2003) argued that their capability lifecycle is valid both for operational and dynamic capabilities, emphasizing that also operational capabilities have the ability to develop without dynamic capabilities influencing on them. According to Eisenhardt and Martin (2000), dynamic capabilities allow firms to reconfigure capabilities in response to changing market conditions. Considering this definition, the sense-and-respond approach can be interpreted as a meta-dynamic capability acting both upon operational and dynamic capabilities. Each dynamic capability, in order to be able to reconfigure capabilities to respond to changing market conditions, has to sense those changing market conditions first. The sense-and-respond approach does exactly that: a change is sensed, the effect on the current way of doing things is interpreted, a decision is made on whether and how to react, and it is acted accordingly. This meta-dynamic capability in form of the sense-and-respond approach is offering a way to research the development of (dynamic) capabilities along their lifecycle in a systematic way.

One principle of the resource-based view is path-dependency, which suggests that the present state of a company is dependent on the decisions it made and the development it went through in the past. When researching why and how certain

decisions inside a company have been made in the past, and how those decisions affected the company's capabilities (e.g. of developing software-enhanced products and services), the adaptive loop can be taken as a basis for systematic research of a company's capabilities. When knowing how and why certain decisions have been made concerning capabilities, those results can be used to support other companies just being on the way to becoming software-enhanced or to carrying out software business in their efforts to successfully make this step.

By combining Helfat and Peteraf's (2003) capability lifecycle with Haeckel's (1995) adaptive loop, a systematic way of researching the development of capabilities is being introduced.

The model – the adaptive capability lifecycle

Helfat and Peteraf (2003) give several examples of how a capability can develop and improve over time, including learning-by-doing, worker-management-relations, individual experience, improvements in operations management and task coordination, capital investment and research and development on the manufacturing process. What is missing from the capability lifecycle is a concept explaining the development of capabilities on a more generic level. Haeckel (1995) introduced the adaptive loop which consists of four stages (sense, interpret, decide and act) and which should help to design extremely change-sensitive processes with rapid response requirements. By combining the capability lifecycle with the sense-and-respond approach, a simple model for researching the development of capabilities on a general level is created.

Upon foundation of a capability in a company, it usually is at an initial, low level. Along the capability's lifecycle, the capability is usually for some time developing in a more or less continuous manner. This continuous development does not have to be initiated actively by an actor (e.g. individuals, teams, groups or the organization), it can happen automatically for example as a result of learning-by-doing. In this case, the adaptive loop poses the central underlying mechanism for change and development. The sense-interpret-decide-act cycle does not have to be carried out consciously by an actor, the actors in "possession" of the capability can unconsciously develop the capability further with help of what they learn-by-doing when using the capability. Part of this continuous capability development anyway can be evaluated and influenced actively by an actor. If this conscious development is not induced by a change in the capability's environment, the actor is consciously trying to develop the capability further (e.g. because of intrinsic motives of an individual or an organization-wide principle of proactive capability development). The actor interprets how the capability could be developed in order to better fulfil its task, and decides for the option that seems best fitting. Finally, the actor acts to develop the capability.

If, however, a change in the environment induces a conscious sense-interpret-decide-act cycle, this can be seen as a selection event. Upon the influence of a selection event, no matter if it happens during the founding, development or maturity stage, the capability might branch. The selection event does not have to be a short-time event, it can as well be some longer-lasting process or change that influences on a capability. For example, the decision to start to develop software is a selection event which most likely will cause a change of the trajectory of some capabilities, but it is influencing on the company and on the company's capabilities over a longer period of time.

There are two sorts of selection events: those that threaten to make the capability obsolete, and those that provide new opportunities for capability growth or change. The selection event can cause one of at least six branching possibilities, the six Rs of capability transformation, consisting of capability renewal, redeployment, recombination, replication, retrenchment and retirement (Helfat and Peteraf, 2003). Upon occurrence of such a selection event the adaptive loop can be used as a tool to analyze the selection of the branch the capability will take. The actor senses the selection event and interprets what this means for the capability. Are there options to develop the capability further or does the capability become obsolete? The actor decides for an option and acts accordingly. After the capability's branching, the adaptive loop is affecting the development of the capability consciously or subconsciously, like already described before. The adaptive loop principle can be used to observe and influence on the further development of the capability along its new branch.

At some point during the development of the capability, the capability might reach the maturity stage, not developing further any more. This maturity stage can be reached by the capability itself e.g. if there is no further learning-by-doing possible for the actor, or the actor might decide that developing the capability further would not bring enough additional value to justify further active development.

Data collection and methodology

So far, the research is being carried out in two companies in Finland: company Consulting and company Automation. Seven interviews have been carried out in company Consulting and two interviews in company Automation. Company Consulting has been established in the 1950ies and offers consulting services to the forest industry. The company has started by offering their services with paper and pen, developed an internal document management system to improve the quality of its services, and finally was spinning off a company offering a document management system and related services to manage the project documentation in big international projects. Company Automation has been established in the 1980ies and belongs to the building automation industry. The

first product (Product A) Automation offered was an analogous heating control device. In the 1990ies, the company stopped developing analogous control devices and developed Product B including already software instead of analogous technology. The company's current devices include much more software than Product B. Additionally, the company offers nowadays a server that enables the control of several different devices over the internet.

Both case companies thus have developed from not developing software to developing and offering software-enhanced products and services. Company Consulting actively started to carry out software business with its spin-off, company Automation is currently making first steps towards software business. At the present time, research in company Consulting has been concentrated on the company's resource base and development of its software development capabilities, whereas research in company Automation has been concentrated on the general development of capabilities within the company.

To verify the above introduced model, it is necessary to empirically research its applicability to real-life circumstances. The research has to be qualitative in nature, as the phenomenon is too complex to be researched with quantitative methods. The qualitative research will be carried out with help of a multiple case study. A case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (Yin, 2003). According to Schramm (1971), "the essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result." As this research is concerned with why and how (dynamic) capabilities related to software business are developed within companies not belonging to the software industry, the case study approach seems to be suitable for this research. The case studies are based on semi-structured interviews in different companies belonging to the traditional industries, and on additional material about the companies like annual reports and web-pages.

The research at both companies is in its beginning stage, but data collected up to date in those companies can already be used to draw first conclusions about the applicability of the model. An example of how to use the adaptive capability lifecycle for researching the development path of and lifecycle of capabilities follows.

Empirical example

To support the above suggested model for researching the development of (dynamic) capabilities, next three examples of how the model can be used to research the development of the case-companies' capabilities are given.

Example 1: Automation’s product development capability

Company Automation was established by two entrepreneurs, both of them having a strong background in real estate automation, and one of them having additionally experience in new product development and commercialization of new products. Know-how about electronic design was bought from outside, and the first product of the company was developed. With time, the founders noticed (**sensed**) that electronic design should be part of the company’s core business. They **interpreted** what it means for the business, and **decided** to take the electronic design know-how inside the company (optionally they also could have decided to further buy this know-how from outside). They **acted** by hiring one of the employees who has formerly designed the electronics for Automation within the subcontractor-company.

An example of how this could be presented graphically in an adaptive capability lifecycle is presented in Figure 3. The decision to take design inside the company, like described above, was made with help of the adaptive loop along the product development capability lifecycle (see loop 1 in Figure 3: electronic design).

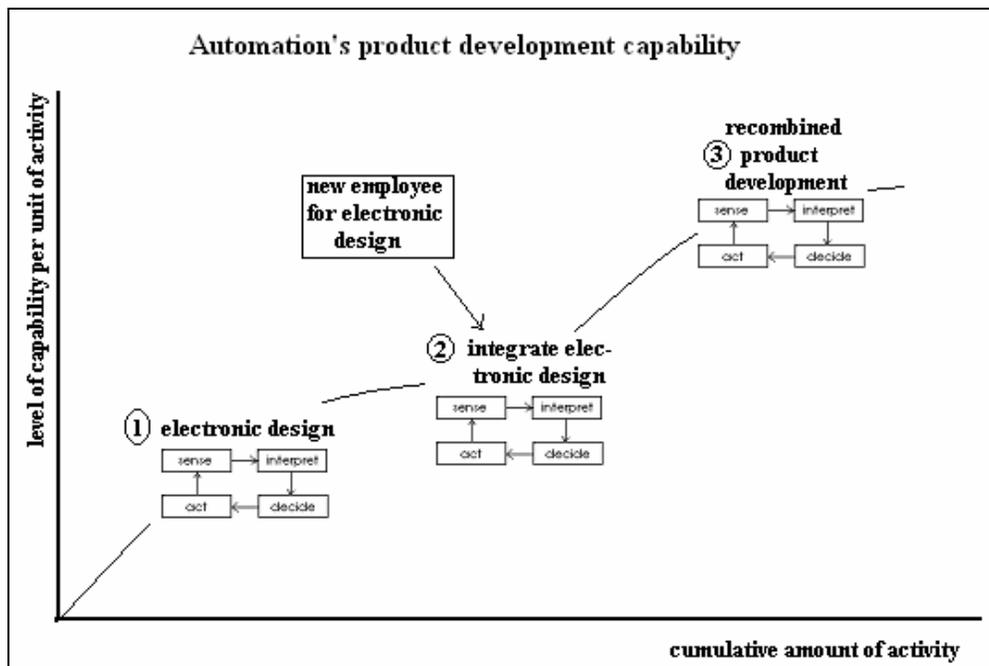


Figure 3. Example of Automation’s product development capability’s development

The initial product development capability was already based in the founder’s know-how, as they had years of experience out in the field. Upon the selection event, the hiring of an electronic design professional, two capabilities were recombined. The already existing product development capability was

recombined with the electronic design capability, extending the original product development capability. After recombination of both capabilities, they developed further together within the “improved” product development capability (see loop 3 in Figure 3: recombined produce development).

Example 2: Automation’s dynamic capability to react to changing market situation

The capability to react to a changing market situation is another dynamic capability Automation possesses. Automation **sensed** a saturation of the main market for their products for small real estate automation. The company **interpreted** that a saturation of the market means difficulties to further grow in Finland. The company **decided** to target at another market segment inside Finland and **acted** by offering a product for big real estate. If Automation would have decided to produce their automation devices for small real estate abroad and change the products to make them fit the market situation abroad, it would have been a redeployment or replication of their product development capability. The decision to enter a new market segment can be seen as renewal or replication of the already before existing product development capability, caused by the dynamic capability to react to a changed market situation.

Example 3: Consulting’s software development capability

Already in the beginning of the 1970ies, Consulting started to develop software for process automation for some external customer. The software worked, and Consulting was selling that software also to one or two other external customers. After some time, Consulting noticed (**sensed**) a change in the market situation as other machine process automation software entered the market (**selection event**). Consulting **interpreted** that in order to really make business with process automation software, the company would have to work tightly together with machine producers who were building those machines whose processes were partly automated with the software. Additionally, machine producers themselves started to get interested in the development of software to automatize and control their machines’ processes. Consulting **decided** to end the development of process automation software, as this stream was not directly connected to the company’s core business functions. Consulting **acted** by dissolving the department responsible for developing the process automation software, transferring the employees having worked there to another IT department, and by concentrating on the development of software supporting their own core business. In that way, the capability to develop process automation software for external customers retrenched and finally was retired (see loop 1 in Figure 4).

Consulting continued to develop its software development capability further during the following 20 years (see loop 2 in Figure 4). The company developed

different software applications for internal process automation, enhancing the delivery of its consulting services. In that way the company became software-enhanced. During that time, there probably occurred several selection events influencing on the software-development capability, but the next selection event this example will illustrate happened in the beginning of the 1990ies. Some of Consulting's customers asked to buy a software application Consulting was using to offer its services to those external customers. Consulting **sensed** that need, **interpreted** it as a possibility to deepen customer relationships, **decided** to sell the internal software application also to outside customers and **acted** accordingly (see loop 3 in Figure 4). The software development capability had to be developed in turn further, as Consulting had to learn that selling software applications to outside customers was not like selling a stand-alone product. The company had to learn that this includes also installation, maintenance services, user trainings and support services. This was learnt-by-doing, slowly developing the extended (by selling the software applications to outside customers) software development capability further with help of the experience actors gained over time (see loop 4 in Figure 4).

Another important selection event was the company's taking part in a TEKES-project at the end of the 1990ies, within which a web-based document management system was developed. The company **sensed** the potential offered by that document management system, **interpreted** the potential as one for the whole company group, **decided** to make that document management system and related services available to the whole group and **acted** by establishing a software spin-off (see loop 5 in Figure 4). This spin-off company was responsible for the further development of the document management system and for offering project document management services to the whole Consulting group. Software development from then on was carried out both inside Consulting and in the software spin-off. The software development capability was developed further both within Consulting (see loop 6 in Figure 4) and in the spin-off company (see loop 7 in Figure 4) in a learning-by-doing fashion, having the adaptive loop as an underlying, unconscious mechanism.

In 2006 management decided to unite the whole Consulting group's software development within the spin-off. Management had **sensed** a need to offer its software development to a broader base than just to the departments the software developers were located in. They **interpreted** this need as having to offer software development more broadly, **decided** to do so and **acted** by transferring almost all software development personnel from Consulting to the spin-off (see loop 8 in Figure 4). From then on, the software development capability was again united within one company, the spin-off, offering its services to the whole Consulting group. How this capability will develop further will turn out during the years to come.

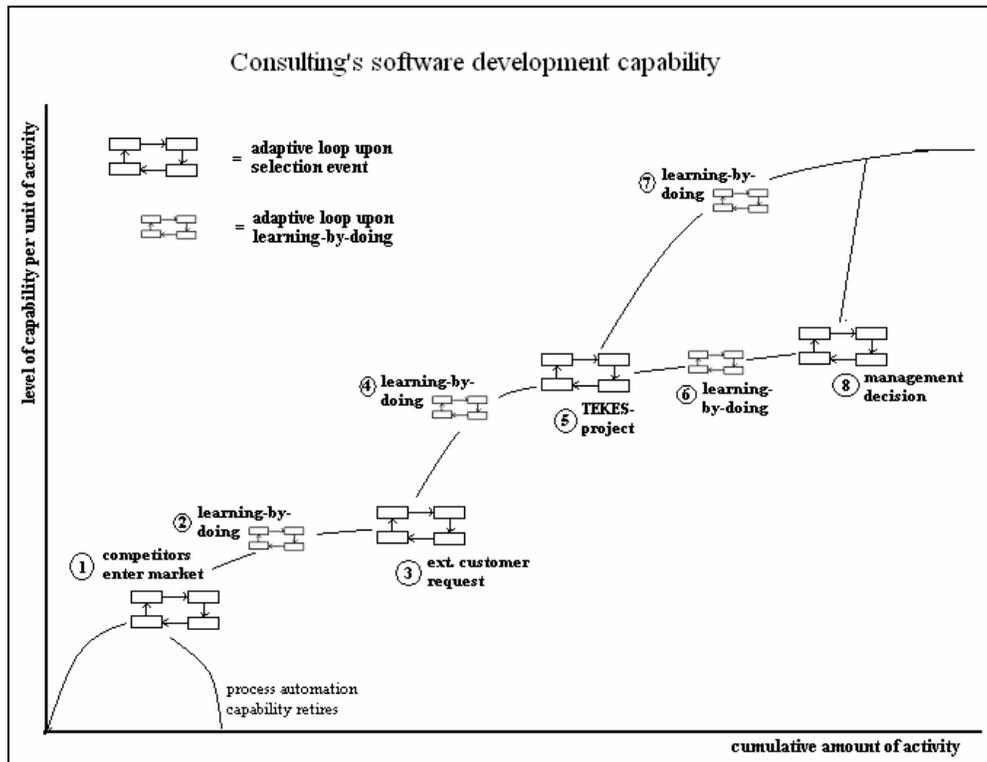


Figure 4. Example of Consulting's software development capability's development

This example illustrates, on a very high level, how the adaptive capability lifecycle can be used to systematically research the development of a capability inside a company. It helps to analyze cause and reaction in a systematic manner, helping to understand the how and why of capability development.

Conclusions

With this paper, the author introduced part of her Ph.D.'s concept, which includes the research of capabilities of companies not belonging to the software industry to successfully enhance products and services with software and later to carry out software business. The model introduced is not yet developed to its full extent, there are still holes that need to be filled in future.

The empirical examples in this paper do not yet illustrate how the model can be used to help research the transition from moderately dynamic markets to high-velocity markets due to a lack of data. In its current presentation, the model can be used to research and analyze the development of different organizational capabilities. The author is convinced that it will be possible to use this model, after having made some further extensions and specifications and after having extended the empirical examples, to research the difference between capabilities

needed in high-velocity and in moderately dynamic markets. Dynamic capabilities in moderately dynamic markets resemble routines and are usually complicated processes, whereas dynamic capabilities in high-velocity markets can not be very complicated. Therefore, companies of moderately dynamic markets might find themselves as having too complicated and too rigid processes and capabilities, not being able to maneuver with help of them in high-velocity markets. By analyzing which selection events have an influence on the capabilities' trajectory, and how capabilities are changing in reaction to it, along with an analysis of how this effects the company's competitive abilities, it should be possible to find out which capabilities of companies operating in moderately dynamic markets are suitable for operating also in high-velocity markets, and which capabilities have to be changed. The current model does not take into company size, product lifecycles and similar factors into consideration, but such extensions are planned to still be made.

For the example of how to use the model, the author used the model to the extent described in this paper, making a first step towards showing the applicability of the model. The model offers a systematic way to research the development of (dynamic) capabilities along their lifecycle, enabling a more systematic comparison between the capabilities needed to carry out business with software in a faster-changing environment, and the capabilities existing in companies of slower changing industries. By using the combination of the capability lifecycle and the adaptive loop, it gives researchers a broader perspective on which possibilities there exist for capability development in case of a change in the environment. This knowledge, in turn, can be used to better advice companies of traditional industries planning to offer software-enhanced products or services. As mentioned before, the development of this model is still at an early stage, it has to be developed further, especially in the context of software-enhanced business and software business. The author anyway believes to have shown the idea behind the suggested model and how it might be applied in research.

References

- Barney, J. B. (1991). "Firm resources and sustained competitive advantage." *Journal of Management*, vol. 17, no. 1, 99-120.
- Barney, J. B. and P. M. Wright (1998). "On becoming a strategic partner: the role of human resource in gaining competitive advantage." *Human Resource Management*, vol. 37, no. 1, 31-46.
- Del Canto, J. G. and González, I.S. (1999). "A resource-based analysis of the factors determining a firm's R&D activities." *Research Policy*, vol. 28, 891-905.
- Eisenhardt, K. and Martin, J.A. (2000). "Dynamic capabilities: what are they?" *Strategic management journal*, vol. 21, no. 10/11, 1105- 1120.

- Ethiraj, S. K., Kale, P., Krishnan, M.S. and Singh, J.V. (2005). "Where do capabilities come from and how do they matter? A study in the software serviced industry." *Strategic management journal*, vol. 26, 25-45.
- Foss, K. and Foss, N.J. (2000). "Learning in firms: knowledge-based and property rights perspectives." *European Journal of Economic and Social Systems*, vol. 14, no. 2, 119-141.
- Haeckel, S. H. (1995). "Adaptive Enterprise Design: the sense-and-respond model." *Planning Review*, vol. 23, no. 3, 6-42.
- Haeckel, S. H. (1999). *Adaptive Enterprise: Creating and Leading Sense-and-Respond organizations*. Harvard Business School Press, Boston, Massachusetts.
- Helfat, C. E. and Peteraf, M.A. (2003). "The dynamic resource-based view: capability lifecycles." *Strategic management journal*, vol. 24, 997-1010.
- Lee, C., Lee, K. and Pennings, J.M. (2001). "Internal capabilities, external networks, and performance: a study on technology-based ventures." *Strategic management journal*, vol. 22, 615-640.
- Lockett, A. and Thompson, S. (2001). "The resource-based view and economics." *Strategic management journal*, vol. 27, 723-754.
- Markides, C. C. and Williamson, P.J. (1996). "Corporate diversification and organizational structure: a resource-based view." *Academy of Management Journal*, vol. 39, no. 2: 340-367.
- Mathiassen, L. and Vainio, A.M. (2005). "Dynamic Capabilities in Small Software Firms: A Sense-and-Respond Approach." *IEEE Transactions on Engineering Management*, forthcoming.
- Penrose, E. (1959). *The theory of the growth of the firm*. John Wiley & Sons, New York.
- Ray, G., Barney, J.B. and Muhanna, W.A. (2004). "Capabilities, business processes, and competitive advantage: choosing the dependent variable in empirical tests of the resource-based view." *Strategic management journal*, vol. 25, 23-37.
- Sallinen, S. (2002). *Development of Industrial software supplier firms in the ICT cluster*. University of Oulu, Department of Marketing, Oulu.
- Schramm, W. (1971). *Notes on case studies of instructional media projects*. A. f. E. Development. Washington, DC.
- Teece, D. J., G. Pisano, et al. (1997). "Dynamic capabilities and strategic management." *Strategic management journal*, vol. 18, no. 7, 509-533.
- Tyrväinen, P., Warsta, J. and Seppänen, V. (2004). *Toimialakehitys ohjelmistoteollisuuden vauhdilla: Uutta liiketoimintaa lähialoilta*. Tekes Teknoliakatsaus 151, TEKES, Helsinki.
- Wernerfelt, B. (1984). "A resource-based view of the firm", *Strategic management journal*, vol. 5, no. 2, 171-180.
- Wolter, H. J. (1996). „Wachstumsmarkt Software.“ in Menke, A., Wimmers, S. and Wolter, H.J. (eds.) *Wettbewerbsbedingungen auf neuen Märkten für mittelständische Unternehmen: eine empirische Untersuchung der Märkte für ambulante Pflegeleistungen, Altautorecycling, Bio- und Gentechnologie*, Software Schäffer-Poeschel, Stuttgart.
- Yin, R. K. (2003). *Case study research, design and methods*. SAGE Publications, London.

Identifying Requirements for Future ERP Systems

Björn Johansson
Center for Applied ICT,
Copenhagen Business School,
Denmark
bj.caict@cbs.dk

Niels Bjørn-Andersen
Center for Applied ICT,
Copenhagen Business School,
Denmark
nba.caict@cbs.dk

Abstract. This paper discusses some of the theoretical challenges in identifying the business requirements for a future standard enterprise resource planning (ERP) package capable of supporting small and medium sized enterprises (SMEs), and is part of the 3gERP project¹. Identifying future business requirements is a task that has a high level of complexity and it is likely that the success of the requirements modeling has high impact on the success story for future ERPs. The paper discusses different ways of developing successful models of needed and future business requirements, and ends up with a model that aims at identifying and presenting business requirements.

Keywords. Business Requirements, ERPs, Requirements analysis, Software requirements.

Introduction

From early on the ambition of ERP-systems has been to: 1) integrate all transaction systems within the same system; 2) share common data and practices

¹ The “Third Generation ERP” (3gERP) project is a large collaborative project between Copenhagen Business School, Computer Science at Copenhagen University and Microsoft. The purpose is to establish the academic and market foundation for developing a ‘standard’ flexible and configurable global ERP-system for Small and Medium sized Enterprises (SMEs), which can be implemented and maintained at a fraction of the current costs.

across entire enterprises, and 3) produce relevant information for decision-making purposes in real-time (Nah et al., 2003; Shanks et al., 2003).

The **first ERP-systems**, introduced in the 1980's were tailor made to the individual organizations. They were extensions of accounting systems, and they were very often very costly to maintain and develop. For small and medium sized enterprises (SMEs) one could hardly talk about ERP-systems, since most just used separate systems including accounting systems.

From the early 90'ies we might talk about the **second generation ERP-systems**. The large organizations introduced very large integrated ERP systems like SAP and Oracle, and although these were standard packages, it is characteristic that they required huge tailoring efforts to meet the requirements of the organizations. There are many reports of implementation being ten times the costs of the ERP license.

For SMEs, ERP vendors typically introduced smaller ERP-packages build on accounting systems, which were gradually extended to cover a wide range of other business processes like supply chain, logistics, CRM systems etc. However, even though modifications to suit the needs of the individual organizations were typically much lower than for large companies, the implementation costs have typically been 1 – 2 times the costs of the license for the ERP-package.

Accordingly, for the SME-market, the focus is on developing what could be called the **third generation of Enterprise Resource Planning (ERP) systems**. Contrary to the systems above, the main objective of the third generation ERP (3gERP) project is to produce the research breakthroughs that will **enable the development of a much more comprehensive ERP-system**, which can be localized to the different countries/industries/enterprises with a minimum of efforts like the MS Office Package, even though an ERP-system is likely to be vastly more complex due to very different requirements. More specifically, the idea is to identify the key elements of a **third generation** of ERP systems for SMEs, which compared to existing ERP systems

- may be distributed globally at relatively low costs,
- will be much easier to implement,
- will be easy to localize to different markets/industries/enterprises,
- will be easy to maintain/update when there are changes in the environment on the international, national, industry or enterprise level (Soh et al., 2000)
- will allow for collaboration between enterprises through easy integration with ERP systems of other enterprises in the value chains/value networks (Akkermans et al., 2003), and
- will provide better business insight (data mining) for managing the enterprises.

Obviously, one of the most crucial questions for this to succeed is that we might somehow identify the business requirements of SMEs. But identifying as well as presenting requirements for information systems as such is a difficult task to

conduct (Alvarez, 2002). There are several reasons why this is a very complex or maybe even an impossible task.

First of all, ERPs are a type of information systems, which are supposed to address all functions of an organization (Worley et al., 2005), from R&D to customer service, from accounting to business intelligence.

Secondly, the challenge is to develop a standard ERP, which should be applicable not just to one organization but to 'all' organizations. The fact that ERPs are not developed for one organization itself increases the complexity of the development.

Thirdly, the basic development is done by software vendors that do not have direct contact with the final user of the software. This to some extent increases the complexity in the development, but one might also argue that it 'shelters the software vendor from the true complexity of the 'real world', and leave these problems to the implementer, who is either faced with modifying the software or simply modifying the organization. This does not differ from other software packages such as for instance office packages.

Fourthly, there is often a "gap" in the understanding of the importance and the use of requirements between the different stakeholders. Schindler (2007) states that requirements in information systems development often are vague and subject to interpretation. The question is then how the gap that often exist between what the business analysts describe as requirements and what the developer want to have when it comes to a more detailed description of requirements can be closed or at least decreased. Is it possible to develop some kind of process for requirements identification, collection and presentation that makes that the development of the future ERP develop better into the direction of what the end users want to have when it comes to functionality received from the system? The question for this paper is: how to capture business requirements when developing "the" future standard ERP package?

The rest of the paper is structured as follows: Firstly we shall briefly discuss why there is a misfit between many ERP-systems and organizations. Secondly we shall attempt an investigation of some of the many attempts at identifying requirements in the literature. Even though in principle it is possible to distinguish between identifying, describing and representing business requirements, this is often not possible in practice and we shall not do it here. Instead, we are discussing these attempts one by one, more or less in chronological order. Thirdly, we present a conceptual model for how to do requirements identification, collection and presentation. Finally there is a short conclusion pointing out some of the future challenges.

Misfits of ERP-systems

One way to describe business requirements on future ERPs could be to relate them to types of misfits between ERP functionality and business requirements as described by Soh et al. (2000). They group the observed misfits in the three broad categories: data, process, and output. The misfits in **data** arise from incompatibilities between business requirements and the ERP package regarding the data format as well as the relationships among entities in the underlying data model, which could be compared to the architecture of the specific software.

Process misfits are described as functional misfits which could be said are about three things. First access misfits, that means the user does not have access to the functionality they need or that the organization lacks enough licenses for the used software. If it is a lack of licenses the customer organization can relatively easy negotiate with the vendor for additional licenses. But if it is about lack of access to a specific function the customer organization also needs to negotiate with the vendor of maybe buying this functionality or alternatively developing this functionality by themselves or by the help of a solution provider. Second, control misfits which mean that the ERPs source code does not allow the introduction of validation routines without changing the source code. Third, operational misfits, which is present when the ERP does not support normal operational steps or the support are inappropriate. The process misfits could be compared to the IT-architecture.

Output misfits are described by Soh et al as the most prevalent form of misfit. This misfit is strictly that the user does not get the information they want to have regarding both the presentation as such or the content of the information. It is stated that this to a great extent can be managed by the ERP system's report writer. However, the report writer is often hard to handle and it is quite often necessary to have an external solution partner to help the customer create the report they need. Output misfits could then be compared to the architecture of the business and it seems that the reason this misfits occurs is because the ERP does not support the business model and/or the business processes in the organization to the degree that is wanted.

The main misfit problem, however, seems to be between ERP functionality and business requirements, and Soh et al., (2000) describe this as a common problem when adopting software package. The problem of "misfit" means that there is a gap between functionality offered by the package and functionality required from the adopting organization. Askenäs and Westelius (2000) describe this in the following way: *"Many people feel that the current ERP system has taken (or been given) a role that hinders or does not support the business processes to the extent desired"* (Askenäs & Westelius, 2000 p 433).

A crucial question that Schindler (2007) raises is that the right people should define the requirements. What Schindler claims is that it often is the wrong

people that identify the requirements and then “throw it over the wall”. This metaphor emphasizes on the fact that it often is business analysts that identify the requirements and these requirements are then very weakly presented to the development staff in an ambiguous way. The development staffs then work from the requirements without questioning these and they do not try to influence requirements that they think are wrong. One reason for the problematic situation is that there exists different views of what actually is required, Alvarez (2002) describes this as a conflict that shows up because of a “communication problem” between analyst and client. It can be stated that this problem shows up despite the fact that most vendors, according to Daneva and Wieringa (2006), have their “standard” process for requirements engineering that they use in establishing new ERP projects, and the reason is maybe that requirement processes are used indiscriminately. Before going into the discussion about how requirements could be identified and presented, it should be asked what the requirements are about.

Business Requirements for Future ERPs

On the general level, it can be argued that the requirements to some extent are obvious. It is clear that the ERP requirements should aim at supporting the organization so that the solution fosters a future development of the organization. But when the chips are down that is very ambiguous. The question is whether it is possible to be more clear about what the requirements should be about, and if so, how to do that.

In the work of identifying business requirements for future ERPs the point of departure is of importance. Point of departure should in this setting be seen as the analytic level from where the future business requirements are identified. Traditionally, points of departures discussed in the literature over the more than 30 years of information systems research has varied substantially.

Originally, a **functional** analysis provided the starting point for any analysis of information requirements. This was especially evident, since most systems were localized to single functions.

Langefors (1976) suggested that **objectives**, in the form of goals for the organization, such as increased profit, better competitive position, and market share should be the starting point of analysis. If only the ultimate objectives could be defined, it would be possible to break these down into more and more detailed objectives, which eventually would result in a definition of information requirements.

Other researchers (e.g. Bjørn-Andersen, 1974) argued that decisions would be a more revealing way to understanding information requirements. If only one could identify the **top management decisions** (eg choice of products, markets, customers), a modeling of these decisions would reveal information requirements. Later **critical success/failure factors** were identified as possible key starting

points for information requirements (Bullen & Rockart, 1981). And again, if the key success and failure factors were identified, we could use these for identification of requirements.

Experience showed, however, that even though each of these point of departures provided insight into relevant aspects of requirements for an ERP-system, none of them came even close to covering the full story. In order to be able to come up with a comprehensive analysis, there is a need for a much more comprehensive approach for information systems requirement for future ERP-systems. The question is then how to find the business requirements for future ERPs.

Since the early 90'ies, the dominant philosophy for identifying business requirements has been **business processes**, and it can be stated that almost all ERPs today are process-based or at least have the attempt of being process-based. This development is among others based on the seminal work of Davenport (1994), but also the work by A.-W. Scheer in Germany has very strongly influenced the architecture of SAP, and has to a large extent inspired Business Process Modeling. It can also be noted that despite the fact that ERPs have focused on business processes for several years, ERP still enforces the concept of best practices when an organization implement an ERP package and that it is strongly argued that the organization should change its business processes to fit the ERP (Soffer et al., 2005) rather than the opposite. The problem with describing business requirements for ERP as business processes according to Rolland and Prakash (2000) is that it enforces different levels of granularity, and alignment to organizational needs is difficult to achieve. The reason for this is that 1) it is extremely hard to manage the amount of details, and that 2) the requirements are often described in terms of goals and objectives for the organization and not in terms of ERP functionality.

According to Volkoff et al, a major business requirement on ERPs is to make sure that the business process is done in the right way. But it could be questioned whether it should not be reversed. For instance that the ERP should allow employees to do the work as they want and that the system should be accommodating and assist in such a way that the result from the business process becomes correct. This could be compared to a problem-based solution or an opportunity-based solution. It could also be compared to an event driven approach where the ERP should support, such as if it should support diverse functions as trading, accounting, production, human resources (HR), and/or customer relationship management (CRM).

Another way of analyzing the requirements is to look deeper into the **business model** as well as the nature of the business. This also means that requirements could be found or specified at different levels in an organization, such as internal (intra-organizational) or external (inter-organizational). Requirements also differ between what kind of organization the ERP is supposed to support, for instance,

service organizations, manufacturing organizations or governmental organizations. All these different dimensions stipulate that requirements can be found at different levels, and it also indicates that the requirements to a great extent are about integration between different dimensions.

Luo and Strong (2004) state that a key issue in ERP implementation is how to find a match between ERP functionality and the business processes of the organization. In other words, how to identify the requirements and the functionality that the ERP delivers. Rolland and Prakash (2000) identifies four views of ERP functionality: content view, form view, purpose view, and the customizing process view. The framework they suggest from these different views can maybe be used to evaluate ERPs from a functionality perspective, but it could maybe also be used as a way of identifying business requirements on ERPs. The different views are described in the following way by Rolland and Prakash: *“content refers to the knowledge that is included in the representation system, form refers to the structure and notation used, purpose refers to the objective fulfilled by the representation system and the kind of use which it facilitates, customization process refers to the process by which the ERP functionality is customized to meet specific organizational needs”* (Rolland & Prakash, 2000 p 188). Both Rolland and Prakash’s as well as Luo and Strong’s call for the importance of matching the organizations need with the ERP-system functionality make it mandatory to further look into how to identify and present business requirements for “the” future ERP.

One way to solve this could be to use **roles** as the base for finding the requirements. To do so the concept role has to be defined. Microsoft Dynamics define roles in the following way: *“A role is a specific grouping of tasks that a persona is responsible for or participates in”* (Microsoft Dynamics, 2006 p 8). Personas in this context should then be understood as a representation of a typical view of the people that can occur within an organization defined by the collection of roles they have. This indicates that a persona can have different roles. Accordingly, looking at business requirements from a role-based perspective means that the ERP should have the technical solution capable of fulfilling new business requirements by providing a one-point access for different work roles in an organization.

According to Worley et al. (2005) the concept of role is particular valuable when describing the interaction between information systems and its users. It is of special interest in ERPs since ERP is an information system that is supposed to support all concerned functions of an organization. This highly intertwined demand means that the ERP has to support a lot of different roles in an organization and the work tasks these roles have. Worley et al. furthermore describe roles as a group of functions aiming at achieving a specific purpose, and they say there are four generic classes of roles found in all organizations: Interpersonal, informational, decisional, and operational roles. These roles then

have specific needs to the software that is supposed to support them. Worley et al. conclude that this means that optimization of ERPs therefore is hard to make since it demands both a change in the system as well as a change in the role. The change in role can be said to be both to change the way people work and change the work process. This can be compared to the discussion about the relation between information technology (IT) and organizational change suggested by Markus and Robey (1988).

An extension of the role analysis is to look into what roles/composite roles that exist in different organizations as well as the kind of combinations of roles that exists. The roles could also be categorized in task-oriented roles or managerial roles, and one might then think of roles as a reverse engineering approach of what different access rights there exists. Finally, another direction of looking into roles and how these roles influences business requirements could be to categorize what decisions and what kinds of decisions are made in different organizations.

Many of these approaches build on the assumption that is possible to bridge the gap between the developer and the user by some kind of joint activity. However, when developing a standard ERP-package it is obviously not feasible to have the full story, since to some extent the developer do not know for whom the system is developed. But, many of the approaches hold a potential for contributing to part of the story. Consequently, we shall attempt to draw upon most of these in order to identify a methodology relevant for identifying requirements of standard ERP-systems in the next section.

A model for identifying and presenting ERP business requirements

There seems to be some kind of trade-off between different stakeholders about the level of business requirements. The one that represents the organizational level probably want to have the requirements on a more abstract level, which suggests that requirements could be described such as: “we want the ERP to support our business processes”, or “we want such and such functionality”. These abstract requirements are not on the level that developers with a more technical viewpoint want to have. The developers’ level of requirements is on the level “what data do you want to be able to see on this screen” or “how many decimals should it be possible to store this information with”.

This trade-off means that there has to be some kind of “translator” between these parties. The question is then what kind of translator there exists or how to do this translation. This directs to the question if there exists some kind of modeling tool that could be of help in doing this, from the discussion so far we suggest narratives and scenarios as tools for finding and presenting business requirements.

According to Hedman and Borell (2004) narratives might be a communication medium suitable for presentation of ERP requirements since narratives can manage a high degree of uncertainty and ambiguity. The statement they make is that *“In fact, narratives might be the only way to capture invaluable input regarding project size and complexity of an ERP implementation”* (Hedman & Borell, 2004 p 287)

Clausen (1994) describes the use of **narratives** in system development and claims that the approach is “more or less” the solution on the problem with the gap of knowledge between end-users and systems designers. This is also a clear improvement over the “trial and error” strategy that is the most common approach for development and implementation software applications.

According to Nielsen (2004), the term narrative has several meanings and includes descriptions of: the human way of organizing experience, the process of telling, as well as the plot structure of a text. She describes the differences between a narrative and a story in the way that a story includes prior events or events the reader of the story has to assume or guess. The narrative on the other hand is described as an organization of events as a movement from a start point to an end point.

Clausen presents two different kinds of narratives that could be useful at different phases in a system development project. The first is “the history” which is a narrative about the existing situation in the investigated organization and describes the situation of a specific user when conducting a specific work task. To have a “useful” narrative, the users have to express their concepts, and the way to catch that could be to use qualitative interviews. The other kind of narrative is “the scenario”. According to Clausen, scenarios are narratives that designers formulate from the empirical narratives – the history – and these could be described as fictional narratives since these should describe the future. The idea is that the designer should work like a composer and create a narrative which communicates the designer’s vision as well as how the designers have interpreted the user’s situation.

Hedman and Borell (2004) state that the potential of narratives is that they can influence action, by conveying meanings, interpretations and knowledge of the system. The conclusion Hedman and Borell (2004) give from their usage of narratives in evaluation of ERPs, is that narratives provides a richer picture on the evaluation and that this knowledge can change the users’ mental maps and thereby improve the use of the ERP evaluated.

Nielsen and Madsen (2006) use stories and narratives synonymously, and they describe **storytelling** as consisting of the four elements: the perspective of the narrator, the agents controlled actions that aim at a goal, the established and followed sequence, and the sensitivity towards the social practices in a given context. According to Nielsen and Madsen narratives have been used in IT literature in four different ways: 1) looking at political explanations for IT

implementation, 2) providing a basis for systems design and development, 3) serving as a technique for requirements analysis, 4) and illustrating IT project post mortems. In this context we would say that the last three are all interesting to investigate further when it comes to identifying, collecting and classifying business requirements for future ERPs.

It is also interesting that Nielsen and Madsen (2006) describe storytelling as a way of sharing knowledge by externalization of tacit knowledge. The gap identified between users expectations of the future system and what the developer perceive as requirements on the same system could be described as lack of knowledge depending on that the different stakeholders has tacit knowledge. Schindler (2007) describes the problem of how developers understand the business requirements as a lack of knowledge about the business processes that the organizations business builds on. According to Nielsen and Madsen (2006) there are generally speaking two different approaches for sharing one's own experience and that of others. Our understanding of the first, which emphasize the learning experience, is that one learns by trying and that one learns over time by participating in projects. The other approach, according to Nielsen and Madsen, is to learn from documentation of earlier projects. They suggest that documentation in form of storytelling, and in particular oral storytelling, is very useful for building a shared understanding. They also state that this is a suitable approach for making sense of past actions as well as envisioning the future.

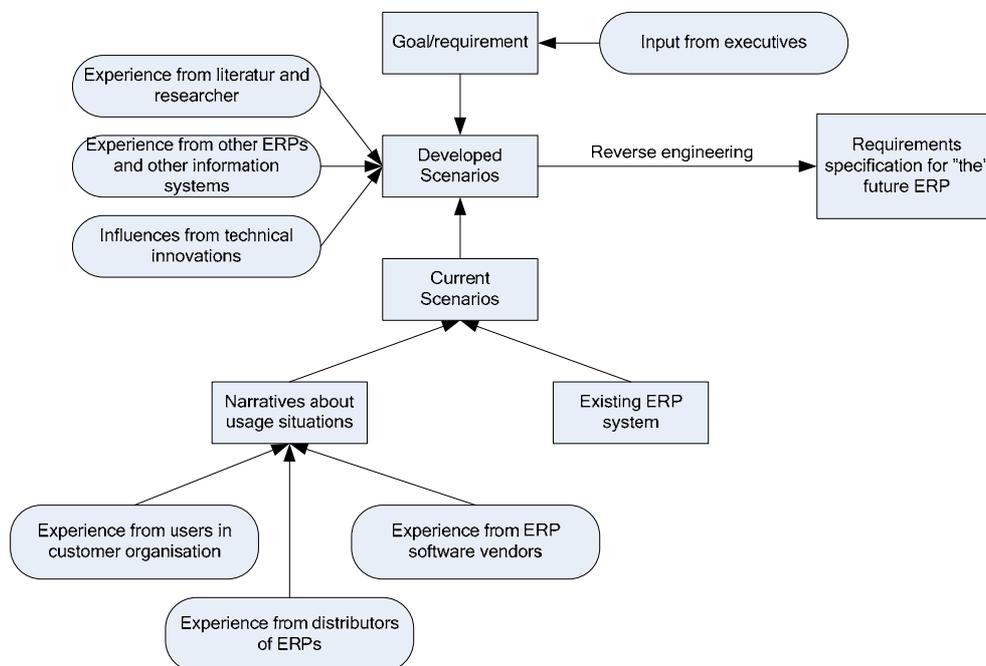


Figure 1 A model for identifying and presenting business requirements for ERPs (based on Jarke et al., 1998 p 157)

From the discussion so far we suggest the model shown in Figure 1 as a model for how to capture business requirements of “the” future ERP. The model builds to a great extent on the idea that narratives can describe “real” requirements. The input to these narratives could come from at least three different stakeholders involved in the development of ERPs. By collecting information in the form of qualitative interviews from “end-users”, ERP software vendors, and ERP distributors (acting as developers in the form of customizing the ERPs) it should be possible to develop empirical narratives. These narratives will to some extent depend on the existing ERP system, but it will probably result in some suggestions for functionality that already is present in the existing ERP, but which for one reason or another not are used. This means that the narratives in addition to knowledge from the existing ERP will show potential for change of the existing system. From this information it will be possible to develop scenarios that describe the current situation. The scenarios of the current situation will then be developed into scenarios about the future using input from literature, experience from other ERP installations as well as ideas regarding influence from technical innovations. By relating the developed scenarios to the organizations goals and requirements for fulfilling these goals, the end result should be a better connection between the requirements and the objectives for the organization. The final step is then a reverse engineering from the scenarios in order to achieve a requirements specification for “the” future ERP. The ambition and goal of the model is to be able to present requirements that are on a level that both developers and executives in the user organizations can agree on as useful.

Conclusion

There are huge challenges in developing a global standardized ERP package. These challenges can be described as belonging to three areas: 1) future ERPs need to be a global product with local reach that can be implemented with a minimum of effort, 2) the business landscape has changed and will change over the years to due to globalization and most organizations will become more and more virtual 3) new technical innovations offers huge potential for increasing the benefits of ERP systems, if these are used correctly.

The fact that the future ERP needs to be a global product with local reach means that the ERP needs to deal with issues of different tax rules, regulations, local practices, competitive landscapes, accounting standards and different languages in different countries. This is a huge challenge.

The changing business landscape can be described as a requirement for dealing with issues as different as, e-commerce, demand for vertical as well as industry solutions, supply chain integration/optimization, and ad hoc reporting (Sammon & Adam, 2005).

The technical innovations that influence future ERPs are abundant. Examples of technical innovations that influence future ERP requirements are: enterprise application integration (EAI), extended markup language (XML), service oriented architecture (SOA), software as a service (SaaS) as well as other forms of external hosting. All of these holds promises of vastly different architectures for future ERP-system, but the question remains whether these are feasible?

In this paper we have attempted a first cut at creating an overview of a large number of recommendations for analyzing information requirements. Some ERP vendors, for instance Microsoft, have a clear strategy of combining business processes with roles. Business processes constitute the organizational (and inter-organizational) building blocks, within which an individual will be responsible for a number of roles, each consisting of tasks. The question is if the suggested model could solve some of the challenges within developing future ERPs. Our next step will be to analyze whether the model could be further developed and augmented with some of the other analyses mentioned above, and to do so we aim at test the model in practice.

References

- Akkermans, H. A., Bogerd, P., Yücesan, E. and Van Wassenhove, L. N. (2003) The impact of ERP on supply chain management: Exploratory findings from a european delphi study. *European Journal of Operational Research* 146 (2), 284-302.
- Alvarez, R. (2002) Confessions of an information worker: A critical analysis of information requirements discourse. *Information and Organization* 12 (2), 85-107.
- Alvarez, R. and Urla, J. (2002) Tell me a good story: Using narrative analysis to examine information requirements interviews during an ERP implementation. *SIGMIS Database* 33 (1), 38-52.
- Askenäs, L. and Westelius, A. (2000) Five roles of an information system: A social constructionist approach to analyzing the use of ERP systems. In *twenty first International Conference on Information Systems*, pp 426-434 Association for Information Systems, Brisbane, Queensland, Australia.
- Bjørn-Andersen, N. (1974) *Informationssystemer for beslutningstagning*. Busck, Khvn.
- Bullen, C. & Rockart, J. (1981) A Primer on Critical Success Factors. CISR no 69, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA
- Clausen, H. (1994) Designing computer systems from a human perspective: The use of narratives. *Scandinavian Journal of Information Systems* 6 (2), 43-58.
- Daneva, M. and Wieringa, R. J. (2006) A requirements engineering framework for cross-organizational ERP systems. *Requirements Engineering* 11 (3), 194-204.

- Davenport, T. (1994) *Business Processes*, Wiley
- Dugan, M. A. (2003) "Envisioning" Beyond intractability. (Burgess, G. and Burgess, H., Eds), Conflict Research Consortium, University of Colorado, Boulder.
- Farbey, B., Land, F. F. and Targett, D. (1995) A taxonomy of information systems applications: The benefits of evaluation ladder. *European Journal of Information Systems* 4 (1), 41-50.
- Hedman, J. and Borell, A. (2004) Narratives in ERP systems evaluation. *Journal of Enterprise Information Management* 17 (4), 283-290.
- Jarke, M., Bui, X. T. and Carroll, J. M. (1998) Scenario management: An interdisciplinary approach. *Requirements Engineering* 3 (3), 155-173.
- Luo, W. and Strong, D. M. (2004) A framework for evaluating erp implementation choices. *IEEE Transactions on Engineering Management* 51 (3), 322-333.
- Langefors, B. (1976): *Theoretical Analysis of Information Systems*, Studentlitteratur, Lund
- Markus, M. L. and Robey, D. (1988) Information technology and organizational change: Causal structure in theory and research. *Management Science* 34 (5), 583-598.
- Microsoft Dynamics (2006) Roles-based business productivity "Software designed for your people". pp 1-57.
- Nah, F.-H. F., Zuckweiler, K. M. and Lau, L.-S. J. (2003) ERP implementation: Chief information officers' perceptions of critical success factors. *International Journal of Human-Computer Interaction* 16 (1), 5-22.
- Nielsen, L. (2004) Engaging personas and narrative scenarios. *Informatics*, Copenhagen Business School, Copenhagen.
- Nielsen, L. and Madsen, S. (2006) Using storytelling to reflect on IT projects. *Journal of Information Technology Theory and Application* 7 (4), 35-47.
- Rolland, C. and Prakash, N. (2000) Bridging the gap between organisational needs and erp functionality. *Requirements Engineering* 5 (3), 180-193.
- Sammon, D. and Adam, F. (2005) Towards a model of organisational prerequisites for enterprise-wide systems integration: Examining ERP and data warehousing. *Journal of Enterprise Information Management* 18 (4), 458-470.
- Schindler, E. (2007) Getting clueful: Five things CIOs should know about software requirements. CIO.com.
- Shanks, G., Seddon, P. B. and Willcocks, L. (2003) *Second wave enterprise resource planning systems : Implementing for effectiveness*. Cambridge University Press, New York.
- Soffer, P., Golany, B. and Dori, D. (2005) Aligning an ERP system with enterprise requirements: An object-process based approach. *Computers in Industry* 56 (6), 639-662.
- Soh, C., Kien, S. S. and Tay-Yap, J. (2000) Cultural fits and misfits: Is ERP a universal solution? *Communications of the ACM* 43 (4), 47-51.
- Volkoff, O., Strong, D. M. and Elmes, M. B. (2005) Understanding enterprise systems-enabled integration. *European Journal of Information Systems* 14 (2), 110-120.

Worley, J. H., Chatha, K. A., Weston, R. H., Aguirre, O. and Grabot, B. (2005)
Implementation and optimisation of ERP systems: A better integration of
processes, roles, knowledge and user competencies. *Computers in
Industry* 56 (6), 620-638.

Strategies for standardization – The case of the mobile industry

Endre Grøtnes

University of Oslo, Norway

endregr@ifi.uio.no

Abstract. This paper explores the alternative forms of standard setting environments (standard strategies) that can be used to produce standards, and present a more fine-grained view of standard strategies that the main distinction in the literature between marked and formal standardization. In this paper the mobile industry is used as a case to illustrate the use of this view/tool.

The case shows that there are many standards activities in the mobile industry. The mobile industry has little de facto standardization but a lot of standardization by different consortia. This is due to the lack of one dominating actor in the domain. The actors have to team up to get enough marked power behind their standard. The formal standardization organizations still perform a large part of the standardization but they concentrate on the core infrastructure while the consortia develop new services and enhancements to the handsets used. There is little direct competition between the different standards activities within the Mobile industry. The only area where there is competing standards activity is in the choice of mobile operating systems for the handsets. Here actors from the IT industry are trying to muscle their way into the Mobile industry.

Keywords. Standards, Strategies for standardization, Mobile industry, Telecommunication.

Introduction and aim

The act of standardization has changed over time. From something a community did to coordinate and make more efficient the production of local goods, to today's global coordination of products and services. Today standards are

developed in many different ways. In this paper the different ways a standard can be developed and become an accepted standard in the market are denoted *standard strategies or strategies for standardization*.

There are many case studies on the development of standards (David 1985; Grindley 1995; Schmidt and Werle 1998; Lehenkari and Miettinen 2005). Most of these focus on how the standards have become accepted standards in the market. Recently some articles have focused on the different choices companies have in choosing where to do their standardization (Hawkins 1999; Werle 2001). The literature mainly focuses on the choice between marked or formal standardization. This distinction is very coarse-grained. To get a better understanding of the standards activities going on within a domain and get new insights from the standard activities, a more fine-grained perspective on the strategies for standardization available to companies is useful.

Some articles have studied the difference between the use of marked standardization and formal standardization within specific industry domains (Funk 1998; Funk and Methe 2001; Markus, Steinfield et al. 2006) but there is a lack of literature to give guidance on, or explain the different strategies available for companies on a general basis (Mattli 2001). This paper will add to the scarce literature on what general strategies for standardization are available for companies.

The first aim of the paper is to give an overview of the different strategies for standardization used today. This overview is drawn from the current literature on standardization in the IS field, and will give a more fine-grained model of standard strategies than the main distinction between de facto and formal standardization is presented. There is a lot of different ways to develop standards (David and Greenstein 1990; Hawkins 1999; Keil 2002; Feng 2003; Stango 2004) and knowing the alternatives can help potential producers in choosing an appropriate standard strategy. Analyzing the use of standards strategies at a fine-grained level can be used as a new perspective, or analytic tool, when exploring and explaining the standards activities within a domain at the macro level.

The second aim is to use this tool in analyzing the standards strategies in a specific industry domain (a data sample) to see what new insights this can give us. In this paper the mobile industry is used as a case. The mobile industry was chosen because it has many actors, the relationships between the actors are changing and the ways standardization is done is also changing (Hawkins 1999; King and Lyytinen 2002; Tilson and Lyytinen 2004). The whole domain is complex and both government and the industry need more information.

Categorizing the standard activities in the mobile domain according to the strategies for standardization used gives a macro view of the situation. According to the interviewees for this case the mobile industry is so complex that few people have a good total overview of the standards activities in the domain. They argue

that there is a need for exploring the different standards activities and the strategies used within the mobile domain.

In the next chapter the research method is explained. In chapter 3 previous researches in standardization and standardization strategies in the IS field are discussed. The case of the mobile industry is presented in chapter 4. Chapter 5 discusses the findings while chapter 6 has some conclusion and suggestions for further research.

Research methods

The research methods used in this paper are interviews, literature studies and participation in standard activities. The participation has spanned seven different standard activities in the period 1998-2006ⁱ.

The research has focused on two tasks: Finding the different general strategies for standardization used by companies, and finding and exploring the specific standard activities within the mobile domain.

The general strategies for standardization that are the basis for the analytic tool/model was found by reviewing existing literature on standardization.

The data sample used was gathered from the mobile industry domain. The mobile industry domain was chosen as a case both because of its complexity and because my current involvement in standardization in the area as a researcher. The challenge was to find all relevant standard activities in the area.

To get an overview of the formal standards activities in the domain the two official standard representatives in Norway were interviewed.

To find pure marked standard activities different industry actors were interviewed.

The consortia involved in standards activities were found by going through two lists of consortia (CEN 2006; Consortiuminfo 2006), following the liaisons statements given in the formal standardizations groups and interviewing participants from the industry. In total 9 interviews were conducted for finding the relevant standards activities in the mobile domain. They come from government, mobile operators and vendors. The list from the European standardization organization is in its 11th revision and contains information on all types of consortia. The list from consortiuminfo.org contains information of consortia in the IT and telecommunication domain.

I went through the lists and picked out the consortia that had standards activities in the mobile domain. With activities I mean that the consortium either develops or promotes standards for the mobile industry. The number of consortia became large so to make it comprehensible the focus was narrowed to standards activities concerned with new technology (not maintaining old technology) and reduced to 24 in total.

The case is mostly exploratory in nature (Yin 2003), giving new insights about the standards activities in the Mobile industry domain. The choice of an exploratory approach is due to the lack of existing detailed information on the activities of the consortia in the mobile domain.

The methods used are a mixed methods approach (Creswell 2003). While using both interviews experience from participating in standardization and going through existing documents and overviews and distilling information I got more ways of finding the involved standards activities and could triangulate the findings.

Standards and standardization strategies

This chapter reviews the literature on standards and standardization strategies in the IS field. It will also act as the basis for the development of the fine-grained model of standard strategies used in the case later on.

Our society is filled with standards. Bowker and Star (2000) emphasises the ubiquity of standards. They are everywhere but unless you work with them you seldom think of them. You just take them for granted, as a part of the infrastructure of a modern society. You expect the light to come on when you turn the switch and the water to flow when you turn the tap. But to get this to work smoothly you need standards.

If you look up the term “standard” in an online dictionary you find a magnitude of definitions. It can mean everything from a military banner, a part of a plant, to a basis for comparison; a reference point against which other things can be evaluated. Bowker and Star defines a standard as any set of agreed-upon rules for the production of objects. Grindley (1995) say that standards define any common set of product features. David and Greenstein (1990) define a standard as a set of technical specifications adhered to by a producer, either tacitly or as a result of a formal agreement. According to the British standards Institute a standard is a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition.

In our context a standard can be viewed as an agreement of the technical specification of a product, or the specification of a process. Standards are voluntary unless they are mandated by law, governments or contracts.

Traditionally standards have been viewed from an economic perspective. See David and Greenstein (1990), Feng (2003) and Stango (2004) for reviews of the literature.

Standards are often divided into two main categories (Grindley 1995; Schmidt and Werle 1998). *Compatibility standards* describe the technical specification or interfaces of products so they can work together with other products, while *quality standards* describe a reference or the minimum quality of a product or process.

Compatibility standards define the interface requirements to allow different core products to use common complementary goods and services or be connected together in networks (Grindley 1995), and contain architectural knowledge by specifying relational properties of technical artefacts (Schmidt and Werle 1998).

David and Greenstein (1990) use the categories reference, minimum quality and interface to divide standards. Reference and minimum quality is the same as quality standards while interface standards are the same as compatibility standards.

An example of a compatibility standard is the standardization of light bulbs with their sockets. An example of a quality standard is the ISO-9000 seriesⁱⁱ.

For compatibility standards a new distinction has emerged within the EU (IDABC 2004). Here they talk of technical interoperability, semantically interoperability and organizational interoperability. Technical interoperability is the specification of technical interfaces for connection devices and services, semantic interoperability is ensuring the precise meaning of the exchanged information while organizational interoperability are the alignment of business models and business goals.

Since standards basically are agreements between different parties, the content of a standard can be developed in different ways.

Traditionally one distinguishes between standards developed by international standard development organizations (SDOs) that are endorsed by governments (de jure standardization) and standards established by the marked (de facto standardization) (David and Shurmer 1996). The first is often called committee standardization and the latter marked standardization. Lately there have been hybrid approaches/initiatives to standardization where the marked and committee approaches to standardization are mixed (Hawkins 1999; Keil 2002). These standardization initiatives are often labeled consortia or alliances. David and Greenstein (1990) put forward four ways a standard can be established: 1) Unsponsored standards originating in the marked, 2) sponsored standards where one firm holds a proprietary interest, 3) standards agreements arrived in standards organizations and 4) mandated standards by government. The first two they label de facto standardization while the two last are de jure standardization.

Today most governments do not develop their own standards but point to the use of standards developed by formal SDOs.

A *strategy for standardization* is the different ways a standard can be developed and become an accepted standard in the marked. Since promoting a standard is essential for its widespread use, establishing a consortium that just promotes a standard can also be viewed as a strategy for standardization.

From the previous discussion one can distinguish the following main strategies for standardization:

- Mandating standards by government
- Development of a standard by a formal SDO (formal standardization)

- Development of a standard by a consortia, alliance or group (consortia standardization)
- Development of a standard by one firm (de facto standardization)
- Promoting of standards by a consortia.

Mandating standards is not a strategy for firms. Firms dictate the use of standards through contracts. This is similar to de facto standardization by one firm. Consortia can have different degrees of openness in their membership policy. The strategies for standardization for consortia will be further divided according to membership structure later in this paper.

Standard by formal SDO's

Formal SDOs operate at national, regional and international levels (David and Shurmer 1996). International and regional SDOs have participants from national SDOs. The participants are both governmental agencies as well as representatives from the industry.

Examples of international SDOs are ISOⁱⁱⁱ, International telecommunication Union (ITU) and International Electrotechnical Commission (IEC). In Europe you have the European Committee for Standardization (CEN), European Telecommunications Standards Institute (ETSI) and European Committee for Electrotechnical Standardization (CENELEC). Typical national standard organizations are BSI in Britain, DIN in Germany and AFNOR in France.

Formal SDOs are standardization organizations with national participation and that are recognised by the various national standards organizations. Formal SDOs are based on consensus, voluntarism, fairness and transparency. The rules and procedures of the SDOs are published, participation is open^{iv} and the result of the process should reflect some common consensus^v.

Standard developed by SDOs are voluntary standards. Before standards from international or regional SDOs become mandatory they have to be incorporated in national legislation or adopted by national SDOs. Everybody can use standards developed by SDOs, but there is often a cost for acquiring the standard and for using the standard to implement a product.

As noted earlier only governments can mandate the use of a specific standards and then it must be incorporated in national law. Governments usually mandate standards developed by one of the regional or local SDOs (David and Shurmer 1996; Werle 2001).

Standards by groups, consortia and alliances

You will find a well of groups, consortia and alliances trying to develop standards. You have large well established organizations like the World Wide

Web Consortia (W3C) and the Internet Engineering Task Force (IETF) who act almost as formal SDOs. Participation in these organizations is open for everybody^{vi}.

The last decades consortia have become a structural feature of standardization and marked co-ordination in the communication technology industry (Hawkins 1999). According to Hawkins a consortium is an informal alliance of firms and organizations that is financed by membership fees for the purpose of co-ordinating technological and marked development activities. CEN edits a list of standards consortium in the ICT area (CEN 2006). The “Standard Consortia List” of April 2006 includes almost 300 consortia. The consortia on the list must have an international membership and must not be set-up specifically as a single-vendor, government, or proprietary technology advocacy group. From this one can see that firms in the ICT and telecommunication industry have a large body of consortia they can participate in.

The different groups differ in their openness in the standard setting process and their openness towards who can become members. Some let all the members participate in the work while other just let a small group participate in the standard setting process (Keil 2002). Some groups are open just for a specific industry, while other are open for all. All groups have in common the wish for their standards to be the accepted marked standard.

Consortia can be distinguished by their membership structure in the following ways:

- Consortia with individual membership
- Consortia with open cross industry membership
- Consortia wit open domain specific membership
- Consortia with closed membership

Standards by one firm

In contrast to standards developed by formal SDOs, a standard developed by one firm is not open for use by everybody. The firm controls the standard and can decide who can use it. Other firms that want to use the standard must often pay a fee for this. The owner of the standard can also chose to make the standard freely available, but this is the choice of the owner, not an inherit part of the process. The use of the standard is up to the marked.

Often are competing standards developed by different firms. Then it is up to the marked to decide which standard to chose. An example of this kind of standard competition is the battle between VHS and Betamax in the area of video cassette recorders (Grindley 1995).

The different strategies for standardization

After reviewing the literature and elaborated on the different strategies I have ended up with the following fine-grained distinction of standard strategies available to companies, table 1. This fine-grained model can be used as an analytic tool or perspective for getting new insights on the standards activities within an industry domain.

Strategies for standardization	Standards activities within a domain
Formal Standardization	
Consortia Standardization	
- Individual membership	
- Open cross industry participation	
- Open domain specific participation	
- Closed membership	
De facto standardization	
Promoting standards	

Table 1 The analytic tool or perspective used to get an overview over standards activities within a domain. The tool is based on a structuring of the standard activities according to the strategies for standardization used.

Using the tool one can chose to view consortia standardization as a broad category or use the more find-grained view of membership structure. The case in this paper will use the fine-grained perspective.

The case of the mobile industry

Standardization of telecommunication networks and services is a complex task. From the standardization of the first generation of mobile networks (1G) to the standardization of today's third generation of mobile networks (3G) the number of actors has increased and the relationship between the actors are evolving (Tilson and Lyytinen 2004). All the different types of strategies for standardization presented previous are present in the mobile industry domain. The different standard activities within the mobile industry are presented according to the tool presented in chapter 3.4. This is the data sample for the analysis.

Formal standardization in the mobile industry

Traditionally governments and International standardization organizations (SDOs) have been responsible for the standardization of telecommunications networks (David and Shurmer 1996; Schmidt and Werle 1998). The formal worldwide standardization organization in the mobile domain is the ITU. ITU coordinates the standardization of the 3G networks and infrastructures through its

IMT-2000 framework (ITU 1999). Much of their work today consists of the regulatory and policy aspects, like frequency management, billing and tariffs, while the bulk of the technical specifications are done by the regional SDOs.

Today the work is done by two different grouping of regional SDOs. The main difference between the two groups is which type of technology the core networks and access networks are based on.

- The Third Generation Partnership Project (3GPP) has participants from Europe, Japan, Korea and the US^{vii} and bases the core network mainly on the GSM standard. Their 3G networks are often called UMTS networks
- The 3GPP2 has participants from the US, China, Japan and Korea and bases the core network mainly on the IS-95/CDMAone standard. Their 3G networks are often called CDMA2000 networks.

ISO also play a part because of its involvement in standards for audio and video content.

Consortia standardization in the mobile industry

The consortia environment for the mobile industry is large. The initial count of consortia that from their own description of aim and activity could be linked with the development or promotion of mobile technologies showed over 40. The relevance of these consortia differs, along with size and membership structure. You have the Open Mobile Alliance (OMA) with open membership and more than 350 members to the 15 members of the Mobile Imaging and Printing Consortium (MIPC) from the printing industry.

To limit the numbers, 24 consortia were picked out for this paper after a thorough review of available lists, liaisons statements and interviews with industry and governmental actors in the domain.

The two consortia with individual membership are the well known organizations IEEE and IETF. Their activities span more than the mobile industry but since they are so influential in their area they have a large impact on the mobile domain. IEEE produces wireless standards while the IETF produces Internet standards.

The largest consortium in the mobile domain is OMA that produces standards for mobile applications. OMA is the merger of many consortia and is today the only consortium making specifications for new mobile services. Two other large groups are the Digital Video Broadcast group (DVB) focusing on digital and mobile TV and the CDMA development group (CDG) developing and promoting the CDMA2000 mobile technology.

There are many consortia making interfaces, frameworks or middleware solutions for integrating the new mobile services and extending the functionality of the mobile handsets. Some of them are The Mobile Industry Processors Interface Alliance (MIPI), The Open Mobile Terminal Platform Group (OMTP),

The open Service Gateway Initiative (OSGi), The parlay Group and the SIMalliance.

You have consortia focusing on one particular technology like the Bluetooth special interest group, Infrared data association (IrDA), Mobile Imaging and Printing Consortium (MIPC), MultiMediaCard Association (MMC) and Standard Mobile Imaging Architecture forum (SMIA).

At last you have Symbian Ltd and The Linux Phone Standards Forum (LIPS) making operating systems for mobile handsets.

De facto standardization in the mobile industry

When one talks about dominant de facto standards the industry today uses two. One is the pre-emptive text input standard T9 while the other is the mobile phone operating system Smartphone. T9 has no real competitors while Smartphone is one among many competing operating systems. Both of these standards have their origin in the IT industry.

Promoting of standards in the mobile industry

There are also many consortia promoting standards. You have organizations like GSM Association (GSMA), UMTS forum, Global mobile suppliers association (GSA) and Tele Management Forum (TMF) promoting the second and third generation of mobile technology. You also have FLO Forum and WiMAX Forum promoting a specific technology and Broadband service Forum (BSF) promoting the use of broadband technologies.

Size and position

The focus or area of standardization, in the mobile industry can also be viewed in light of the part of the infrastructure where they contribute. The new mobile 3G infrastructure is often divided into the following parts: The handsets, the access network, the core network and services (3GPP 1998; Lescuyer 2004; Lehenkari and Miettinen 2005).

The formal SDOs are concentrating their work on the core network and the access networks, while the consortia are focusing on the handsets, the services and promoting the technology in general.

The standard activities vary in size. The formal SDOs have a large and cross-industry participation. The consortia promoting standards also have a large and cross-industry member base. The two consortia with individual members are the largest with participants in the thousands.

Most of the consortia are small with industry specific participation. As noted earlier the largest consortium is OMA. The other consortia with cross industry participation also have a member base of 100+.

The strategies used in the mobile industry domain

Table 2 gives an overview of the different strategies used by the standards activities in the mobile industry domain.

Strategies for standardization	Standards activities in the mobile domain
Formal Standardization	3GPP, 3GPP2, ITU-T, ISO
Consortia Standardization	
- Individual membership	IEEE, IETF,
- Open cross industry participation	CDG, DVB, LIPS, OMA, Parlay Group,
- Open industry specific participation	IrDA, OMTP, MIPI, MIPC, MMC, OSGi, SIM alliance, SMIA, IrDA,
- Closed membership	Bluetooth, Symbian
De facto standardization	Smartphone, T9
Promoting standards	BSF, FLO Forum, GSA, GSMA, UMTS Forum, TMF, WiMAX Forum

Table 2 The standards activities in the mobile domain categorised according to the strategies for standardization used.

Discussion of the findings

This chapter discusses the findings from using the tool on the mobile industry domain.

The mobile industry value chain broadly consists of mobile operators, mobile equipment vendors, IT vendors and content and service providers. According to Tilson and Lyytinen (2004) new industry participants like content providers, computing firms and alternative technology providers have entered the wireless (Mobile) industry. Today the mobile industry consists of a diversity of actors, some originating from the telecommunication industry, others coming from IT and media.

The mobile domain has many large companies, but few of them have a monopolistic or very dominating position. Although four companies have 75 percent of the intellectual property rights for the core elements of the third generation mobile infrastructure (Goodman and Myers 2005), there are areas like the handsets, the operating systems, the services and the content that still is open for new development. Even the core network of the infrastructure is under development with the introduction of new IP based capabilities.

A first glance at the strategies for standardization used in the mobile industry domain can seem chaotic, but there is some order in there. According to Genschel (1997) the fragmentation in the domain gives the actors better possibilities to use different strategies for standardization and thereby avoid deadlock situations.

The bulk of standardization is done by formal and consortia standardization. The formal standardization organizations are typically involved with the

standardization of the core network and the access network, while the consortia focus on the handsets and the new services. There is for instance a tacit understanding between OMA, the largest consortium, and the formal SDOs. OMA is focusing on the services while the formal SDOs are focusing on the technical parts of the infrastructure.

Even the division between the two main technologies used in today's new mobile networks have been formalized and settled with the two partnership projects.

The two individual membership organizations are bringing new technologies to the industry. IEEE is giving alternative wireless access methods and the IETF is bringing IP and packet switched networks into the core mobile network. They both have a large influence in the IT industry domains and this influence is so great that the mobile industry also is adopting their standards. The technologies developed in these consortia are generally viewed as vendor neutral.

There are few de facto standards in the mobile domain, but there are a lot of groups promoting standards or a specific technology. This is because to introduce a de facto standard a company must have a dominant market position or a unique standing in the domain. In the mobile domain there are many large companies, but none with a position dominant enough to dictate standards. The result is that companies group together to promote standards and to develop standards. The de facto standards used in the mobile industry have their origin in the IT industry.

The largest standardization activities in the domain are those with open cross industry participation, individual membership and the formal standardization organizations. Standardization meetings in these organizations typically have more than 400 participants. The work in these organizations is also divided into subgroups so not all work is done in one large group.

A typical trend for the mobile domain is the many standardization activities with industry specific participation. The companies have to team up to get enough power and momentum behind their technology to introduce it in the market. One can typically see this in the many consortia developing standards to enhance the functionality of the mobile handsets. You have consortium for putting cameras into the mobile handsets, multimedia cards, infrared technology and printing capabilities. Here otherwise competitors team up to introduce new functionality and thereby making their market larger. The fear is that without a common standard the handset vendors will produce their own enhancement to the handset and thereby closing the market. As some of the interviewees said "*It's better to get a small piece of a large pie, than no piece at all*".

One area of standardization in the mobile domain is different from the others, the standardization of mobile operating systems. Some vendors use their own operating system, there is a consortium with closed membership developing standards, a consortium trying to develop an open source operating system and there is a dominating actor from the IT industry trying to impose its proprietary

operating system on the mobile industry. Here they have the same structure as in the IT industry. Two of the operating systems are also operating systems that are adapted from the IT industry. The Linux vs. Microsoft battle is continuing in the mobile arena, but here they meet competition from the existing actors. The Symbian initiative can be seen as an attempt to stifle the competition from Microsoft by developing a common operating system by the existing mobile vendors.

The standardization of operating system for mobile handsets is the only area where there is direct competition between different standards initiatives in the mobile industry today. Here the different standardization attempts are in direct competition with each other.

The main buyers in the domain are the mobile operators. They are competitors but they team up in consortia like the GSM association, Tele Management Forum, the UMTS Forum and CDMA development group to harmonize their views and promote common requirements to the vendors. The buyers like to buy standardized products. Standardized production of goods leads to reduced prices and more competition (Grindley 1995). The operators also participate in standardization and try to influence the standards requirements processes there.

The standardization activities in the mobile industry are based on cooperation. The standardization process used to be dominated by the governments (David and Shurmer 1996; Funk 1998) with little de facto standardization. Even with the transformation from formal to consortia based standardization the cooperation within the industry is upheld. De facto standardization is brought along from dominating market actors within other industry domains.

Conclusions

The fine-grained division of standard strategies proposed in this paper can be used to gain new insights into the standards activities within the mobile industry domain. The model was developed partly based on research findings from the mobile industry so the generality of the model must be validated by analyses of other industry domains. The findings here can also be a starting point for further studies on strategies for standardization within the mobile industry domain.

The analysis has shown that the strategies of standardization used within the mobile domain are mainly formal and consortia standardization. There is little de facto standardization. This is mainly due to the fact that even with many large firms there are no dominant actors in the domain. The vendors team up to promote and develop standards within different consortia.

The mobile industry is also adopting standards from large individual membership organizations like IETF and IEEE based in the IT industry. The de facto standards in the mobile industry domain also have their origins in the IT industry.

There is little competition between the different consortia and formal organizations. They have divided the work between them. Today the only area within the mobile industry with competing standards is the area of mobile operating systems. Here the structure of the IT industry has been brought to the mobile domain.

In the near future one can see an emerging competition between different standards for connecting the handset to the 3G or other infrastructures. This should be investigated further.

Appendix - List of consortia

Name	Abbreviation	Standards /specifications
Bluetooth special interest group	Bluetooth	Bluetooth
Broadband services forum	BSF	Broadband content
CDMA Development Group	CDG	CDMA 2000
Digital Video Broadcasting Project	DVB	DVB
FLO Forum	FLO forum	Mediaflo
Global mobile suppliers association	GSA	General
GSM Association	GSMA	GSM
Institute of Electrical and Electronics Engineers	IEEE	802.11 + more
Internet Engineering Task Force	IETF	H.323 + more
Infrared Data Association	IrDA	IrDA
The Linux Phone Standards Forum	LIPS	Operating system
Mobile Image and printing consortium	MIPC	Pictbrigde
The Mobile Industry Processor Interface Alliance	MIPI	hardware interface /API
MultiMediaCard Association	MMC	MMC cards
Open Mobile Alliance	OMA	OMA drm + more
Open Mobile Terminal Platform Group	OMTP	Application framework + more
Open Services Gateway Initiative	OSGi	Middleware
The Parlay Group	Parlay	API
SIMalliance	SIM alliance	API (SIM)
Standard Mobile Imaging Architecture forum	SMIA	Cameras to phones
Symbian Ltd	Symbian	Operating system
Tele Management Forum	TMF	General
UMTS Forum	UMTS Forum	UMTS
WiMAX forum	WiMAX Forum	Wimax

References

- 3GPP. (1998, 2006-04-24). "The 3rd Generation Partnership Project (3GPP) description and agreement." Retrieved 08.11, 2006, from <http://www.3gpp.org/About/about.htm>
- Bowker, G. C. and S. L. Star (2000). *Sorting things out*.
- CEN. (2006, April 2006). "The list of ICT consortia by the European Committee for Standardization (CEN), 11 edition." Retrieved 08.11, 2006, from <http://www.cenorm.be/cenorm/businessdomains/businessdomains/iss/consortia/consortia.asp>
- Consortiuminfo (2006). *Consortium and standard list. 2006*.
- Creswell, J. W. (2003). *Research design. Qualitative, quantitative and mixed methods approaches*, SAGE Publications.
- David, P. A. (1985). "CLIO and the economics of QWERTY." *The American Economic Review* 75(2): 332-337.
- David, P. A. and S. Greenstein (1990). "The economics of compatibility standards: An introduction to recent research." *Economic of innovation and new technology* 1: 3-41.
- David, P. A. and M. Shurmer (1996). "Formal standards-setting for global telecommunication and information services." *Telecommunications policy* 20(10): 789-815.
- Feng, P. (2003). *Studying standardization: A review of the literature*. IEEE 3rd conference on standardization and innovation in information technology, IEEE.
- Funk, J. L. (1998). "Competition between regional standards and the success and failure of firms in the world-wide mobile communication market." *Telecommunications Policy* 22(4): 419-441.
- Funk, J. L. and D. T. Methe (2001). "Market- and committee-based mechanisms in the creation and diffusion of global industry standards: the case of mobile communication." *Telecommunications policy* 30: 589-610.
- Genschel, P. (1997). "How fragmentation can improve co-ordination: Setting standards in international telecommunications." *Organization studies* 18(4): 603-622.
- Goodman, D. J. and R. A. Myers (2005). *3G cellular standards and patents*. 2005 International conference on wireless networks, communications and mobile computing, IEEE.
- Grindley, P. (1995). *Standards, strategies and policy : cases and stories*, Oxford university press.
- Hawkins, R. (1999). "The rise of consortia in the information and communication technology industries: emerging implications for policy." *Telecommunications policy* 23: 159 - 173.
- IDABC (2004). *European interoperability framework for pan-European eGovernments services. Interchange of Data between Administrations, Businesses and Consumers*. E. Commission.
- ITU (1999). *Recommendation Q.1701 (03/99) - Framework for IMT-2000 networks*, ITU.
- Keil, T. (2002). "De-facto standardization through alliances - lessons from Bluetooth." *Telecommunications policy* 26: 205-213.
- King, J. L. and K. Lyytinen (2002). "Around the cradle of the wireless revolution: the emergence and revolution of cellular telephony." *Telecommunications policy* 26: 97 - 100.
- Lehenkari, J. and R. Miettinen (2005). "Standardisation in the construct of a large technological system - the case of the Nordic mobile telephone system." *Telecommunications policy* 26: 109-127.
- Lescuyer, P. (2004). *UMTS Origins, Architecture and the Standards*, Springer.
- Markus, L. M., C. W. Steinfield, et al. (2006). "Industry-wide information system standardization as collective action: the case of the U.S. residential Mortgage industry." *MIS Quarterly* 30(Special issue): 439-465.

- Mattli, W. (2001). "The politics and economics of international standards setting: an introduction." *Journal of European Public Policy* 8(3): 328-244.
- Schmidt, S. K. and R. Werle (1998). *Coordinating technology: Studies in the international standardization of telecommunications*, MIT press.
- Stango, V. (2004). "The economics of standard wars." *Review of network economics* 3(1): 1-19.
- Tilson, D. and K. Lyytinen (2004). "The 3G Transition: Changes in the U.S. Wireless Industry." *Sprouts: Working Papers on Information Environments, Systems and Organizations* 4(3): 131-150.
- Werle, R. (2001). "Institutional aspects of standardization - jurisdictional conflicts and the choice of standardization organizations." *Journal of European Public Policy* 8(3): 392-410.
- Yin, R. K. (2003). *Case study research; Design and methods*. London, SAGE publications.

ⁱ IETF, W3C, OMA, The Open Group, ETSI, CEN and ISO

ⁱⁱ ISO 9000 is a generic name given to a family of standards developed to provide a framework around which a quality management system can effectively be implemented (BSI).

ⁱⁱⁱ ISO is the official short form for the "International organisation for standardisation". Because "International Organization for Standardization" would have different abbreviations in different languages ("IOS" in English, "OIN" in French for *Organisation internationale de normalisation*), it was decided at the outset to use a word derived from the Greek isos, meaning "equal". Therefore, whatever the country, whatever the language, the short form of the organization's name is always ISO. (Taken from the ISO official website at

<http://www.iso.org/iso/en/aboutiso/introduction/index.html#three>

^{iv} Participation is open but is often coordinated through the national SDOs.

^v Each SDO has its own voting procedure with different levels of for reaching consensus.

^{vi} Only organizations can be member of W3C and only individuals can be members in IETF, but there are no restrictions on which firms and individuals that can be member.

^{vii} The 3rd Generation Partnership Project (3GPP) is a collaboration agreement between a number of telecommunications standards bodies. The standards bodies are known as "Organizational Partners". The current Organizational Partners are ARIB, CCSA, ETSI, ATIS, TTA, and TTC.

The Role of Problem Management in Customer Support: A Case Study

Marko Jäntti, Niko Pylkkänen

University of Kuopio, Department of Computer Science, P.O.B 1627, 70211
Kuopio, Finland
mjantti@cs.uku.fi

Abstract. IT organizations need systematic methods to manage the increasing number of service requests and software problems reported by customers. A large number of open problems can rapidly increase the costs of software maintenance and development. Therefore, an IT organization needs a well-defined customer support model. However, existing customer support models have one major shortcoming: a lack of process description that shows the interaction between different support processes (incident management, problem management and change management) and their activities. In this paper, we use a constructive research method to build an improved support process description. Additionally, we present findings of a case study that was focused on improving support processes in a medium-sized Finnish IT company. The research question in this paper is: What is the role of the problem management process in customer support?

Keywords. Customer support, problem management, IT Infrastructure Library

Introduction

Customer support processes are often the most visible part of the IT organization to customers. By improving the quality of the support processes, IT organizations can easily increase the customer satisfaction on services and products. Additionally, the world-wide interest in IT service management processes such as IT Infrastructure Library ITIL (OGC(1) 2002) and COBIT (COBIT 2004) provides evidence that the research area is important. In this paper, we focus on two service support processes: incident management and problem management.

IEEE Standard Classification for Software Anomalies (IEEE 1994) states that anomalies (problems and defects) may be found during the review, test, analysis, compilation, or use of software products or applicable documentation. A Framework for Counting Problems and Defects by the Software Engineering Institute emphasizes the same activities. It identifies five major activities to find problems and defects (Florac 1992): software product synthesis, inspections, formal reviews, testing and customer service. Florac (1992) defines software product synthesis as "the activity of planning creating and documenting the requirements, design, code, user publications, and other software artifacts that constitute a software product".

Software inspection is a formal evaluation technique in which requirements, design or source code are examined to detect defects (Ebenau and Strauss 1994; Bush 1990). The important role of inspections has been noted already in 1970's. Following steps can be identified in inspection process: entry, planning, kickoff meeting, individual checking, logging meeting, edit, follow up, exit, and release (Gilb and Graham 1993). Inspections are an efficient way to find defects from documentation but require an experienced inspection leader that is able to produce appropriate checklists and metrics for the inspection process, and organization-wide rules and guides.

Formal reviews include for example, defect causal analysis (DCA) meetings, service reviews, and problem reviews. A defect causal analysis method is based on the data received from a software problem report. The DCA approach has three major principles (Card 1998): 1) Reduce defects to improve quality: software quality can be improved if the organization focuses on preventing and detecting defects in early phase of software development. 2) Apply local expertise: people who really know the cause of the failure and how to prevent problems in the future should participate in causal analysis meetings. 3) Focus on systematic errors: DCA people should select a sample of systematic problems from a problem database to be reviewed because support resources are limited and it is impossible to bring all problems and defects into DCA meetings. A DCA meeting could include the following steps: select problem sample, classify selected problems, identify systematic errors, determine principal cause, develop action proposals, and document meeting results.

Service review meetings belong to the activities of the service level management process in ITIL (OGC(2) 2002). The purpose of service review meetings is to review how service level requirements were met in the last service period, to identify weak areas in the service, for example the root cause of service breaks, and to define required improvement actions.

Problem reviews (OGC(1) 2002) are quite similar than defect causal analysis meetings (Leszak et al. 2000) The purpose of problem reviews is to review the problems that have a high business impact. Problem reviews are focused to determine what was done right and wrong in problem resolution, what could be

done better next time and how to prevent the problem from occurring again in the future.

Software testing is a process of executing a program on a set of test cases and comparing the actual results with expected results. The testing process requires the use of a test model that is a description about what should be tested and how testing should be executed (Kruchten 2001). Previous studies have emphasized the need of shifting testing to early phases of software development process such as requirements and specification phase and design (Binder 2000; Jäntti and Toroi 2004).

Customer service including support processes is a wide concept. In fact, it can involve the other above mentioned problem finding activities. There are various theoretical frameworks and models regarding service support and managing problems and defects available for IT organizations: First, maturity models are designed for measuring the maturity level of software development processes or service management processes (Pink Elephant 2004, COBIT 2004). Perhaps the most well-known maturity model in software engineering is the capability maturity model CMM (Jalote 2000). There is also a specific CMM model for IT Service management CMM (Niessinka 2005). Second, quality standards (ISO 20000 service management standard, ISO/IEC 12207) include auditable requirements for processes (ISO/IEC 2006; ISO/IEC 1995). Third, there are IT service management process frameworks that define how to perform support processes: ITIL (OGC(1) 2002), COBIT (COBIT 2004), and Microsoft Operations Framework (Microsoft 2007). Fourth, software development lifecycle models (Rational Unified Process (Jacobson et al. 1999), for instance) also include information on quality assurance methods such as testing, risk management and defect prevention. Finally, academic literature provides a wide selection of other quality assurance models such as Defect Management Process (Quality assurance institute 1995), the framework for counting problems and defects (Florac 1992) Personal Software Process (Hirmanpour and Schofield 2003) and software maintenance models (Kajko-Mattsson 2004; Kajko-Mattsson, 1998; April et al. 2005).

However, all above mentioned models seem to have one major shortcoming. They do not include a process description that would show the interaction between different support processes as one diagram. The improved model should include incident management activities (identify & record, classify, investigate, and resolve incident), reactive problem management with problem control activities (identify & record, classify, investigate, and resolve problem, error control and proactive problem management), change management and application development. We call this model "a big picture of support processes".

The main contribution of this paper is 1) to provide an improved support process description and 2) to present experiences of a case study where we used

that process description to improve support processes in a medium-sized Finnish IT company.

The rest of the paper is structured as follows: The second section describes the research methods used in this study. Third section presents the results of the study including the process description. The fourth section is the analysis of case study findings. In the discussion and conclusions part, the conclusions are presented.

Research question and methods

This case study is a part of the results of the SOSE research project (Service Oriented Software Engineering) at the University of Kuopio, Finland. The research question in this paper is: **What is the role of the problem management process in customer support?** Both constructive and case study research methods were used in this study. First, we build a theory-based model for customer support using a constructive research method. A theory consists of four key elements: a boundary that describes the domain of interest, key constructs within the domain, the values that constructs may take, and the relationships between the constructs (Eiermann 1995). Our model is based on the ITIL process framework (service support section) because ITIL is the most widely used service management framework in the world (OGC(1) 2002).

A case study can be defined as *"an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident"* (Yin 2002). Case studies can be categorized into exploratory, explanatory and descriptive case studies. Our study is more exploratory than explanatory or descriptive because we did not have any predefined hypotheses in the study and did not focus on finding cause-effect relationships.

Our case organization Alfa supplies solutions for the navigation industry. Alfa is focused on mobile phones and portable devices. Data collection methods included informal discussions in research meetings with Alfa. Persons who participated in research meetings were a researcher and research assistants from SOSE research project, a quality manager (Alfa), and a support engineer (Alfa). The analysis of case study findings focused on identifying strengths and challenges in Alfa's support processes. The study was carried out according to the following schedule:

- September 14, 2006: Alfa and the SOSE research team defined goals for the pilot project (improving support processes: incident management and problem management)
- September 19, 2006: Alfa introduced the support process to the SOSE research team

- October - December, 2006: The SOSE research team analyzed the support process of Alfa by using ITIL process framework as a benchmarking target.
- January 11, 2007: The results of the analysis (identified challenges) were presented in a review meeting (Alfa and SOSE)
- January - March 2007: SOSE research team (a research assistant) evaluates knowledge base / FAQ manager applications and their properties
- March 1, 2007: The results of the tool evaluation were presented to Alfa. As a result of the evaluation, the best tool was selected and installed.
- March, 2007: The FAQ manager tool was configured, and user manuals and a new process description created
- March 27, 2007: The FAQ manager tool, the process description were reviewed with a sample case (a customer sends a problem ticket, the first line support creates a draft FAQ item, the second line support approves and publishes the FAQ item. (Alfa and SOSE)

The role of problem management in customer support

The customer support process (see Figure 1) usually begins when a customer encounters a problem while using a service or a product and takes contact to the service desk (by phone, by email or by a web form). This contact, that is related to customer's or user's problem is called an incident. An incident can be defined as "any event which is not part of the standard operation of a service and which causes, or may cause, an interruption to, or a reduction in, the quality of that service" (OGC(1) 2002). It is important to distinguish service requests from incidents. Service requests can be defined as "a request from user for support, delivery, information, advice or documentation, not being a failure in the IT infrastructure" (OGC 2005). A good example of a service request is a user's request for more disk space.

While the goal of incident management (the process performed by the service desk function) is to restore normal service operation as quickly as possible, problem management aims to minimize the impact of problems on the business and to identify the root cause of problems. The key difference between problem management and incident management is that in problem management, the quality of the resolution plays a more important role than the resolution time. The first important question is **what are the process inputs, main activities and the process outputs?**

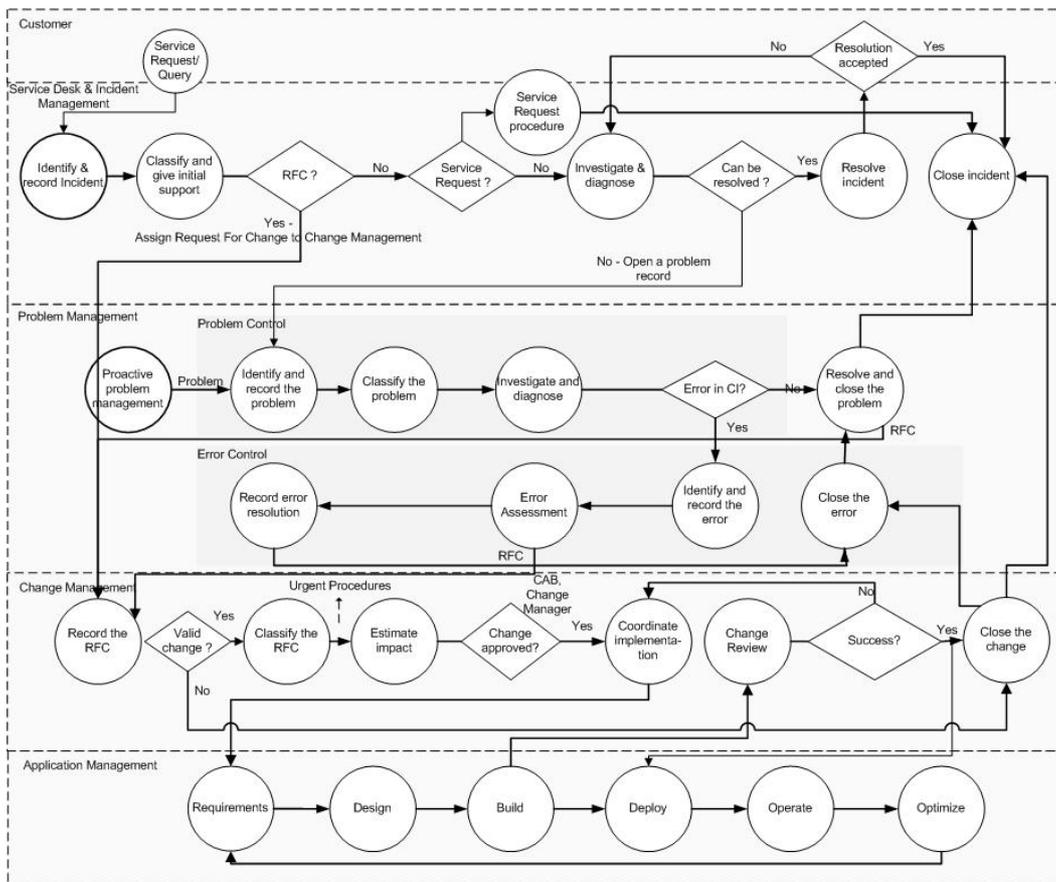


Figure 1. A process diagram of service support activities.

In practice, process descriptions of IT organizations tend to focus only on activities and forget the clear definition of inputs and outputs. Figure 2 describes the inputs, outputs and key activities of the problem management process.

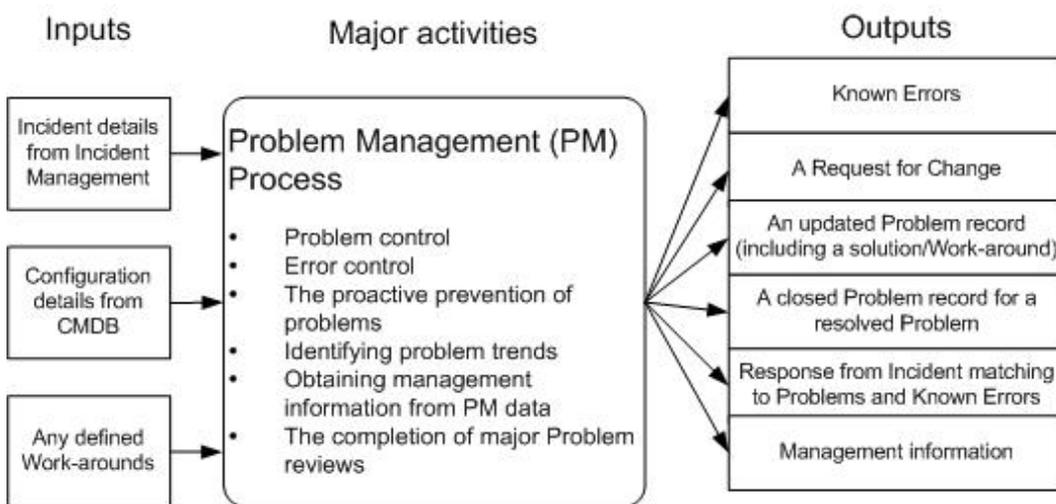


Figure 2. Inputs, outputs and key activities of the problem management process.

Problem management has both reactive and proactive aspects. Reactive problem management aims to resolve incidents and problems reported by customers. This is a traditional task of any service desk or help desk. The proactive problem management in turn tries to prevent incidents before they occur. Proactive activities work in a similar way than defect prevention activities (Mays 1990). Reactive problem management is divided into problem control and error control activities where the problem control is responsible for identifying the root cause of a problem (Zhen 2005) and defining a temporary solution (work-around) for the problem. Figure 3 describes reactive (problem control and error control) and proactive activities of problem management.

The second important question is **when does the incident management process stop and when does problem management process start?** Problem control (the first phase of the reactive problem management process) begins when incident analysis reveals repetitive incidents, or the incident does not match any of the existing problems or known errors. Additionally, when incidents are defined as very serious and significant, they are sent directly to problem control.

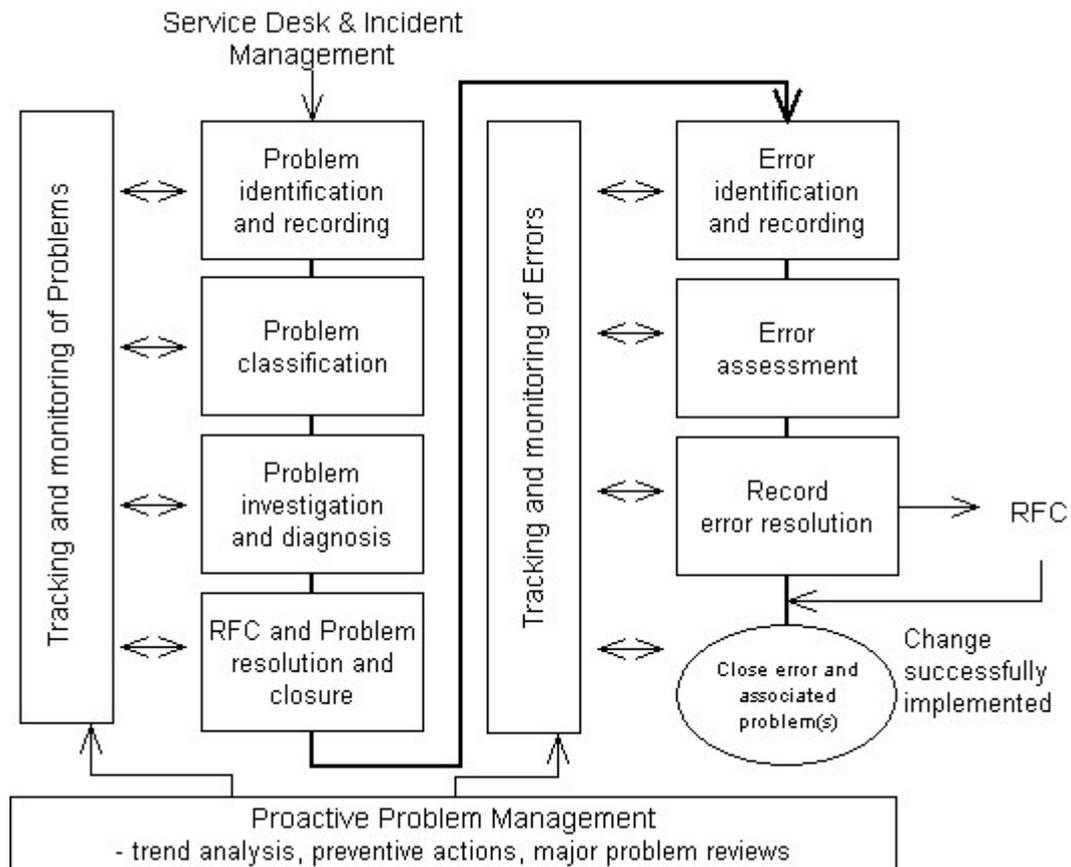


Figure 3. Problem management activities.

The content of problem control and error control phases are explained in ITIL process description and in our previous work. First, the problem management team identifies and records the problem (enters a basic description of problem). Second, the problem management team classifies the problem (defines category, impact, urgency and priority). Third, the problem is investigated and given a diagnosis including the root cause of the problem. In this phase problem management might create a Request for change to implement a problem resolution. A Request for change is “*a formal part of the change management process, used to record details of a request for a change to any configuration item (CI) within an infrastructure, or to services, procedures and items associated with the infrastructure*”.

The third important question is **when does the problem control activity stop and when does the error control activity start?** The error control process focuses on correcting known errors by generating request for changes to change management. The basic activities of error control are error identification, error assessment, recording error resolution. Errors can be found both from users and customers (live environment) and testing and development (development environment). According to ITIL “*known error status is assigned when the root cause of the problem is found and a workaround has been identified*” (OGC(1) 2002). We have interpreted this rule that the error control activity begins when the root cause of the problem is a defect (in code or in the IT infrastructure). Error assessment consists of identifying means how error could be resolved. Error resolution might require a contact to third-party service providers or technology providers. Finally, the error resolution (symptoms and resolution actions) should be recorded into known error database or a knowledge base. A knowledge base is a database for knowledge management. It can be used for collecting, organizing, and searching the knowledge. The knowledge base usually provides its users with solutions to known problems (Davis 2002, Jackson et al. 1998). A well-designed knowledge base helps both service desk and customers to find solutions for problems quickly (Jäntti and Vähäkainu 2006).

Improving customer support processes: case Alfa

Table 1 shows the general findings related to the support process of Alfa. Data was collected in the research project meetings between Alfa and the SOSE research team.

	Case Alfa
Goals for process improvement	Alfa needs information on <ul style="list-style-type: none"> - How to "ITILize" existing concepts of the support process - How to build an ITIL- compliant support process - Need for a knowledge base with a multilanguage support
Tools used for managing incidents and problems	Open source Service management tool Open source bug tracking tool
Workflow asset	Issue
A description of the support process	A process diagram exists.
Service Support levels	1st line: outsourced service desk 2nd line: support engineer 3rd line: sales
Metrics	# of support requests /month % of missed calls # support requests by type # of open requests /week % of calls answered < 20 seconds, < 30 seconds # of support requests resolved within one working day, next working day, 3rd working day
Proactive methods	- training of retailers - monitoring user forums - a static FAQ column on the support site - testing
Major challenges	- A product development and a sales unit do not use service management tool

Table 1. *The support process of an IT company Alfa*

Customer calls and emails are assigned to an outsourced service desk. The service desk is responsible for the first line support. If the service desk is not able to resolve the problem, the help desk issue (incident) is escalated to the second line support. Alfa also has third line support that is responsible for handling business-related service requests such as overcharging on the Alfa e-commerce site.

The performance of the support process is measured by using various metrics such as the number of customer calls answered in less than 20 seconds and the number of missed calls. Service desk and incident management uses an open source based request tracking application that is configured to Alfa's needs. The service desk records all customer contacts (incidents and service requests) into a request tracking application. Although the service desk has been outsourced to an external service provider, the second line support and a quality manager of Alfa are also able to monitor all the recorded customer requests and problems. Alfa uses a term "Problem Ticket" for customer requests and problems. The same Problem Ticket goes through the whole support process. Problem Tickets are categorized by types (for example, licence problem, question, installation).

Problem tickets are not formally prioritized when they are recorded into request tracking application although it is possible to define the priority level for the problem record. However, the second line support performs some kind of prioritization for tickets. Alfa's quality manager stated that there has been no need to prioritize cases because Alfa is able to resolve most cases within a couple of days without priority levels.

The request tracking application also includes a module for managing frequently asked questions. Alfa uses this FAQ module to share information within the organization. The FAQ module enables publishing knowledge base articles to support the work of the first-line and second-line support. However, Alfa second line support stated that it is difficult to publish knowledge base articles for customers through the FAQ module because of the poor language support. Alfa would like to obtain a dynamic FAQ application that would decrease the number of the customer contacts to the service desk.

Problems that are assigned to the second-line support are investigated. If the root cause of the problem is an application bug, the problem will be recorded as a bug into bug management application. The traceability between the request tracking application and the bug management application is maintained by recording the request ID to the bug record. Thus, there is a connection between a customer request/problem and a bug. Alfa does not have a process of handling request for changes. Required changes are usually implemented in the next version of the application.

Analysis

The analysis of case study focused on identifying strengths and challenges in Alfa's support processes. We analyzed whether Alfa's support process includes the same activities, roles, and tasks than our improved support process description. The following table presents the results of the analysis (strengths and weaknesses in Alfa's support processes).

Strenghts	Weaknesses/Challenges
1. Customer contacts are sent to the Service Desk, which takes care of the first line support.	1. The support process documentation does not include activities or roles of service desk and incident management.
2. Measurable targets have been defined for the Service Desk and the incident management processes. The progress of Incident handling is monitored.	2. Measurable goals have not been defined for the problem management process.
3. Employees in the Service Desk are well educated (customer service, technical knowledge) and people are trained continuously (e.g. new features in products).	3. ITIL concepts are not visible in the support process.
4. All the reported cases are recorded to the incident database and those cases are updated when necessary.	4. The lack of a public knowledge base
5. Incidents are categorized according to predefined instructions.	5. The customer does not get confirmation when the incident has been taken under processing or moved to the second level support.
6. There is a bridge between the problem control and the error control: problem id is stored in the error record to maintain the traceability between those cases.	6. There is no unified tool to handle incidents, problems and defects.
7. Three support levels are recognized in Service Support process (outsourced Service Desk, Problem Management and third line support).	7. Priority of the incident or the problem is not defined in Service Desk or in problem management.
8. Problems concerning the products of third party providers are stored and handled.	8. The processes and activities of problem control, error control and proactive problem management are poorly defined.
9. Standardized reports are produced regularly about incident and problem rates.	
10. The organization has recognized the need for proactive problem management.	

Table 2. *Strenghts and challenges in Alfa's support processes*

The first challenge was that Alfa's support process did not include activities of service desk and incident management. The solution is to describe these activities in the process diagram (according to our model in section Service support). As a benefit of solving this problem, the transparency of service desk and incident management process will increase. Thus, the employees are better able to identify the interfaces between different support processes and improvement areas regarding customer support.

The second challenge was the absence of measurable targets in support process documentation although the targets were set to the Service Desk and incident management processes. By defining those targets it is possible to estimate the forthcoming workload, measure the effectiveness of processes and to recognize the problem areas. This data can be used in proactive decision making and to improve the operation of the organization.

The third challenge was that ITIL concepts were quite unfamiliar to the organization's people. Therefore, it was a challenge to combine the ITIL concepts and Alfa's own concepts together. More information and training related to ITIL was needed in the organization.

The fourth challenge was the lack of the knowledge base. The good thing was that all the reported cases were recorded in the incident database. Publishing those cases and their results in a public knowledge base would result in great benefits as customers could search problem resolutions from the knowledge base. This would reduce the number of reported cases.

The fifth challenge was that a customer does not get any confirmation when the incident is taken under processing or moved to the second level support. Informing the customers better about cases and the progress of problem handling will increase the level of customer satisfaction. It also reduces the unnecessary inquiries from the customer.

The sixth challenge was that the service desk and problem management used different tools for problem management and bug management. This might cause a communication gap between first second line support and product development. However, this challenge was eliminated by including the identification number of a customer request to a bug record.

The seventh challenge was that the priority level of problems and incidents was not recorded by service desk. This can cause difficulties in identifying the most critical faults and lead to a long bug correction time. ITIL (OGC(1) 2002) recommends using the standardized model for defining the priority level of incidents and problems. The priority level is defined by urgency and business impact. This makes possible to manage the most critical problems first.

The final challenge was that the processes and activities of problem control, error control and proactive problem management were not defined in a sufficiently detailed level. The resolution is to define and describe the activities of those processes. For problem control those activities are recognition, storage,

classification, investigation and diagnosis of the problem and for error control: recognition, storage, evaluation and result storage of the error. Additionally, proactive problem management activities need to be defined: a trend analysis of incidents and problems, defining the preventive actions and organizing major problem reviews. These activities help to reduce the workload of the service desk. A description of the proactive problem management activities will clarify its design and implementation steps.

Discussion and Conclusions

In this paper, we answered the research question: What is the role of the problem management process in customer support? As the main contribution of this study we first presented a theory-based model for customer support (with strong focus on problem management) by using a constructive research method. We defined the process inputs, main activities and the process outputs for the problem management process and presented an improved process model where activities of different support processes were described. Some frequently asked questions related to ITIL-based problem management were also discussed, such as when does the incident management process stop and when does problem management process start and what is the interface between problem control and error control.

Second, we presented results of a case study that focused on improving the support process in a medium-sized Finnish IT company "Alfa". Alfa's support process was examined and analyzed whether it includes the same activities, roles, and tasks than our improved support process description. As a key improvement area we identified that Alfa's support process documentation does not include a comprehensive definition of the activities of service desk, incident management and problem management. ITIL based concepts such as knowledge base, incidents, and known errors are not visible in the process description. However, Alfa's support process also had several strengths. For example, they had defined three support levels, they monitored continuously reported problems and had defined a wide selection of metrics for monitoring the performance of support process. The contributions of this paper can be used by problem managers and quality managers to improve problem management processes.

As with all case studies, there are following limitations and validity threats regarding our study. The case study methodology has received a frequent criticism concerning the generalization of research results. If a study is based on a single case, it cannot provide statistical generalizations. However, we can expand the theory. Regarding construct validity, researchers should ensure that the data is collected from several sources. In this study, the main sources of data collection

were a quality manager and a support engineer of Alfa. Product developers did not participate in the meetings.

In future studies we intend to improve our research framework by examining proactive problem management from IT customer's viewpoint. We shall also continue the introduction of ITIL-based support processes with new case organizations. Additionally, we need to collect empirical data to show that our recommendations for problem management will lead to better results.

Acknowledgments

This paper is based on research in the SOSE project (2004-2007), funded by TEKES (the National Technology Agency), European Regional Development Fund (ERDF), ICT and customer companies in electricity domain.

References

- April, A., Huffman Hayes, J., Abran, A. and R. Dumke (2005). Software maintenance maturity model (smmm): the software maintenance process model: Research articles. *J. Softw. Maint. Evol.*, 17(3):197–223.
- Binder, D. (2000). *Testing Object Oriented Systems*. Addison Wesley.
- Bush, M. (1990). Improving software quality: the use of formal inspections at the jpl. In *ICSE '90: Proceedings of the 12th international conference on Software engineering*, pages 196–199, Los Alamitos, CA, USA, 1990. IEEE Computer Society Press.
- Card, D. N. (1998). Learning from Our Mistakes with Defect Causal Analysis. *IEEE Software*, January-February
- COBIT (2005). *COBIT 4.0. Control Objectives for Information and related Technology*. IT Governance Institute.
- Davis, K. (2002). Charting a knowledge base solution: empowering student-employees and delivering expert answers. In *Proceedings of the 30th Annual ACM SIGUCCS Conference on User Services* (Providence, Rhode Island, USA, November 20 - 23, 2002). SIGUCCS '02. ACM Press, New York, NY, 236-239.
- Gilb, T. and D. Graham (1993). *Software Inspection*. Addison-Wesley.
- Ebenau, R.G. and S.H. Strauss (1994). *Software Inspection Process*. New York, NY: McGraw-Hill.
- Eierman, M.A., Niederman, F., and C. Adams (1995). Dss theory: a model of constructs and relationships. *Decis.Support Syst.*, vol. 14, no. 1, pp. 1–26.
- Florac, W. A. Software Quality Measurement (1992). A Framework for Counting Problems and Defects. *Technical Report*, CMU/SEI-92-TR-022, The Software Engineering Institute, Carnegie Mellon University.
- Hirmanpour, I. and J. Schofield (2003). Defect Management through the Personal Software process. *Article in Crosstalk, The Journal of Defense Software Engineering*.

- IEEE (1994). *IEEE Standard Classification for Software Anomalies*, IEEE Standard 1044-1993, p. 3.
- ISO/IEC (1995). *ISO/IEC 12207, Information Technology: Software Life-Cycle Processes*. ISO/IEC Copyright Office.
- ISO/IEC (2006). *ISO/IEC 20000 A Pocket Guide*. Van Haren Publishing.
- Jackson, A., Lyon, G., and J. Eaton (1998). Documentation meets a knowledge base: blurring the distinction between writing and consulting (a case study). In *SIGDOC 98: Proceedings of the 16th annual international conference on Computer documentation*, pages 5–13, New York, NY, USA, ACM Press.
- Jacobson, I., Booch, G. and J. Rumbaugh (1999). *The Unified Software Development Process*. Addison-Wesley.
- Jalote, P. (2000). *CMM in Practise, Processes for Executing Software Projects at Infosys*. Addison Wesley.
- Jäntti, M. and T. Toroi (2004). UML-based Testing: A Case Study. *Proceedings of 2nd Nordic Workshop on the Unified Modeling Language* (Turku, Finland, August 19-20, 2004).
- Jäntti, M., and K. Vähäkainu (2006). Implementing a Knowledge Base for Software Problem Management. *Proceedings of the IASTED International Conference on Knowledge Sharing and Collaborative Engineering (KSCE 2006)*, November 29-December 1, 2006, St. Thomas, US Virgin Islands.
- Kajko-Mattsson, M. (1998). A conceptual model of software maintenance. In *Proceedings of the 20th international Conference on Software Engineering* (Kyoto, Japan, April 19 - 25, 1998). International Conference on Software Engineering. IEEE Computer Society, Washington, DC, 422-425.
- Kajko-Mattsson, M., Ahnlund, C., and Lundberg, E. (2004). CM3: Service Level Agreement. In *Proceedings of the 20th IEEE international Conference on Software Maintenance* (September 11 - 14, 2004). ICSM. IEEE Computer Society, Washington, DC, 432-436.
- Kruchten, P. (2001). *The Rational Unified process, an introduction*. Addison-Wesley.
- Leszak, M., Perry, D. E., Stoll, D. (2000). A case study in root cause defect analysis. *Proceedings of the 22nd international conference on Software engineering*, June.
- Microsoft (2007). Microsoft Operation Framework MOF. Retrieved March 20, 2007, from <http://www.microsoft.com/technet/solutionaccelerators/cits/mo/mof/default.aspx>
- Mays, R.G. (1990). Experiences with Defect Prevention. *IBM Systems Journal*, Vol 29 No. 1.
- Niessinka, F., Clerca, V., Tijdinka, T., and H. Vlietb (2005). *IT Service CMM Version 1.0, Release Candidate 1*.
- Office of Government Commerce (1) (2002). *ITIL Service Support*. The Stationary Office, UK, Ref. use in text, OGC(1).
- Office of Government Commerce (2) (2002). *ITIL Service Delivery*. The Stationary Office, UK, Ref. use in text, OGC(2).
- Office of Government Commerce (2005). *Introduction to ITIL*. The Stationary Office, UK.
- Pink Elephant (2004). ITIL Process Maturity, Pink Elephant Whitepaper. Retrieved November 8, 2005, <http://www.pinkelephant.com/en-US/ResourceCenter/PinkPapers/PinkPapersList.htm>
- Quality Assurance Institute (1995). *Establishing A Software Defect Management Process*. Research Report number 8.
- Yin, R. K. (2002). *Case Study Research, Design and Methods*, 3rd ed. Newbury Park, Sage Publications.
- Zhen, J. (2005). IT Needs Help Finding Root Causes. *Computerworld*, vol. 39, pp. 26.

Modeling Tool for Designing Usable Mobile Services

Heli Wigelius

Institute of Human-Centered Technology
heli-anneli.wigelius@tut.fi

Anne Aula

Institute of Human-Centered Technology
anne.aula@gmail.com

Maiju Markova

Institute of Business Information Management
maiju.markova@tut.fi

Tampere University of Technology

P.O. BOX 589

FI-33101 Tampere, Finland

Phone +358 3 3115 11

Abstract. Currently, the methods for illustrating the business benefits of mobile business services to decision-makers are scarce. Furthermore, the methods for communicating usability requirements and problems to the developers may not be optimal. This paper presents a method called Mobile Business Service - Unified Modeling Language (MoBiS-UML) that can be used to analyze the potential of mobile business services by comparing the current (as-is) and mobile (to-be) process models. The modeling approach also makes it possible to analyze the actual use of the service by enriching the mobile process model with information from user studies. By including the observations from user studies, the model illustrates the usability gaps for the service developers in a concise manner. To demonstrate the practicality of the approach, we modeled the safety measurement process performed at construction sites and demonstrated the benefits and problems related to the use of the mobile business service.

Keywords. Business, Mobile services, Usability, Process modeling, UML.

Introduction

Mobile business services allow work to be done independently of location or in the most appropriate location through access to central information systems. For example, on-site customer service personnel, construction workers, and taxi drivers need information while on the move. If mobile services are used to support this work, the expected benefits are large. However, benefits of mobile business services are vastly influenced by the early design decisions and the subsequent success of the final design. In the early phases of design, it is important to study how to best utilize the mobility of the service in the work process: What are the phases in the work process that could be eliminated or made more efficient? Can the mobile service help deliver information for the actors at the right time? What benefits can the service offer for the businesses deploying the service? After designing the service with these questions in mind, the service should, *in theory*, successfully support the work process. However, the support for the process *in practice* may deviate from what was expected.

The differences between the support in theory and in practice can result from many sources, including the usability of the service. By definition, *usability* refers to the effectiveness, efficiency and satisfaction by which the users can use the system for their specific tasks in a specified context of use (ISO 9241-11, 1998). In this definition, effectiveness means the “accuracy and completeness with which users achieve specified goals”, efficiency refers to the “resources expended in relation to the accuracy and completeness with which users achieve goals”, and satisfaction is defined as the “freedom from discomfort, and positive attitudes towards the use of the product”.

Often, usability is only linked to the user interface (UI) of the system. However, a wider view on usability requires that the whole service (including the device, the logic of the software, UI, network connections) supports the work and the wider business process. This wider view is important especially when designing mobile business services. Mobile business services are used via different devices, like Personal Digital Assistants (PDAs), mobile phones or devices designed for specific tasks (*e.g.*, devices used by taxi drivers and conductors). Limitations caused by both the mobile devices and the mobile environment make the design of successful mobile services a challenge. Slow network connections, limited memory size, input and output limitations (Johansson *et al.*, 2006), as well as varying levels of lightning, temperature, and noise may decrease the effectiveness of use as well as user satisfaction. These factors, as well as making sure that the device is portable and supports multitasking (from working while walking to working while driving a car) should be taken into account when designing mobile services (Johansson *et al.*, 2006; Yuan & Zheng, 2005).

This paper provides a method for designing usable mobile business services by modeling work processes and observing usability of services. Through a case study, we present modified Unified Modeling Language (UML) Sequence Diagrams, or Mobile Business Service-UML (MoBiS-UML), specifically tailored for the current context. In the case study, we examined and modeled the safety measurement process at construction sites in Finland.

We argue that a formal method for evaluating the potential of the service and its performance benefits different stakeholders. First, *the service developers* could model the current way of performing work tasks and find phases in the process where mobile service could support efficient task flows. This analysis would also make it possible to study the financial potential of the service. Enhancing the model with usability observations would facilitate the developers' understanding on the problematic phases in the process and help in finding solutions to them. Second, *the representatives of the customer company* (the company deploying the service) could evaluate the benefits of the service before making the decision to purchase by comparing current work process (as-is) and new process (to-be) that is performed with the mobile business service. Finally, *the end users'* work performance and work satisfaction would increase as the service would optimally support their work.

Background

The ultimate goal of businesses developing services is to provide financial value for their owners. Although it is impossible to list all the actions that result in revenue, usability of the end product has repeatedly been linked to the success of different products and services (Heppner *et al.*, 2005; Marcus, 2005). In addition, we claim that the potential benefits of mobile business services can only be achieved if the service is usable – poor usability can result in the work becoming inefficient, the work satisfaction decreasing, or even in the service not being used at all. Thus, the usability has effects on the business performance of the companies that are deploying these services (Markova *et al.*, 2007).

As stated in the Introduction, designing usable mobile business services is challenging. However, there are several practical methods that will aid in this task. For example, *user involvement* is important in the development process (Phillips *et al.*, 1988) having a positive effect on the success of services and user satisfaction (Kujala, 2002). In *participatory design*, end-users act as active members in the design team instead of being only passive customers. Participatory design is an iterative process that improves the end-product and the work environment on the whole (Dix *et al.*, 2004; Mackay, 2004). *Multidisciplinary approach* and *iterative design* are the main principles of *human-centred design* (ISO 13407, 1999). Human-centred design also emphasizes the

importance of understanding and specifying the context of use, including the users, tasks, and the organizational and physical environment (ISO 13407, 1999).

Mobile business services have both the potential to support the user in the specific work task and also to benefit the business processes through real-time data, improved flow of information, and by deleting unnecessary tasks from the business processes (Sheng *et al.*, 2006; Verbarg *et al.*, 2006). *Task analysis* provides ways to analyze how people perform their work (Dix *et al.*, 2004) and to study their work environment. GOMS (Goals, Operators, Methods and Selection rules) is a formal method that makes it possible to make detailed predictions on the users' performance using computer systems (Card *et al.*, 1983). However, requiring a detailed analysis of every elementary action, this approach is not particularly efficient for modeling the performance in complex work processes with multiple actors. For modeling work tasks, Philips *et al.* (1988) use operational sequence diagrams. Their graphs can also be translated into verbal form although Eriksson and Penker (2000) argue that a visual model is easier to understand than a textual description. Mori *et al.* (2002) introduce a notation called Concur Task Trees Environment (CTTE) to support the design of interactive applications for industry via modeling the user's tasks. The shortcoming of CTTE and the other task analysis models for the current purposes is that they focus on modeling the users' tasks, but they do not take into account the whole business process and its different stakeholders. Measuring the potential benefits requires a consideration of the business process context in which the mobile service is to be deployed (Davern & Kauffman, 2000).

Methods for improving business processes through information technology include business process reengineering (BPR) (Davenport, 1993) and business process modeling (BPM). According to Lee (2004), three major stages of BPR include "the analysis of existing processes, establishment of redesign objective, and design of new and improved processes" (p. 219). BPM can be seen as a tool for BPR – BPM aims at structuring activities of an enterprise as either an as-is model (current situation) or a to-be process (proposed situation) (Tam *et al.*, 2001). According to Virine (2003), business processes can be visualized using different diagrams, graphs, and interactive tools. The diagrams that are used in modeling business processes are, for example, activity diagram (Aversano & Canfora, 2002), P-graph (Valiente & van der Heijden, 2002; Kadyte, 2005) and flow chart (e.g., Virine, 2003). In addition to these, business processes can be modeled using Unified Modeling Language (UML) (see, e.g., Eriksson & Penker, 2000).

For our modeling purposes, we chose to use UML; a modeling approach that has been used both in the fields of business performance and software development. UML provides nine different diagrams for different purposes. UML also describes functions and relationships that may be difficult to visualize otherwise (Eriksson & Penker, 2000). According to Dobing and Parsons (2006),

Class, Sequence, and Use Case Diagrams are the most commonly used UML diagrams in software projects. We chose UML Sequence Diagrams for our purposes because UML has a standard notation and developers are already familiar with UML in general, and with Sequence Diagrams in specific (Eriksson & Penker, 2000). UML is also supported by many tools for modeling information systems and business processes (Eriksson & Penker, 2000).

Although UML is traditionally being used in software engineering, it provides a “common grammar” for service developers and business users (*e.g.*, marketing, management, decision-makers in the customer company). Sequence Diagrams in particular make it possible to present detailed information about the interactions between the different mobile actors as well as the order of interactions; the other modeling methods mentioned above do not fulfill both of these requirements. Furthermore, the other modeling methods do not make it possible to model the business point of view and usability findings together. Further shortcoming of the models specifically intended for business process modeling is that they often include only the inputs and outputs of the whole process instead of modeling the single work task. Thus, the user requirements and interactions between the user and system are not highlighted. Correspondingly, work task analyses do not concentrate on the whole business process, and therefore, they do not take into account interactions between several stakeholders and potential benefits to the whole business process that could be obtained by using the mobile service.

Next, we will illustrate how we utilized the modified UML sequence models for studying how a mobile service can benefit the safety measurement process (TR-measurement) at construction sites. We will show how to model the work process with and without the mobile service. In addition, we will show how the models help to communicate the observed usability problems in the service prototype to the service developers.

Methods

The goal of the study was to develop a method for modeling mobile business processes and for illustrating the benefits of and the problems related to the use of mobile service in business use. To achieve this goal, we conducted a case study in 2006. The data was gathered through workshops, interviews and observations. The case company, Buildercom Ltd., is a leading information management application service provider for construction and real estate maintenance industries in Finland. Buildercom offers information management services for the whole lifecycle of buildings (Buildercom, 2007). Buildercom also develops mobile services that can enhance the basic information management services by, for example, making it possible to send information to databases in real-time. Currently, Buildercom provides mobile services that can be used in quality

inspections, in issues related to the maintenance of the buildings, and in safety measurement.

In this case study, we studied the mobile service for weekly safety measurement, or TR-measurement (Laitinen *et al.*, 1999). Briefly, TR-measurement aims at improving the safety at worksites by checking that various safety regulations (*e.g.*, the use of helmets) are followed. In Finland, the TR-measurement is required by law. During the TR-measurement process, the worksite is checked by walking around the site and making observations on a formal checklist. Two people participate in each measurement: a site supervisor and an industrial safety delegate.

To gain a deep understanding of the business process where the mobile business service was used, we run a workshop. The representatives of Buildercom (CEO, business field manager, and product manager) explained the safety measurement process from their (service provider) point of view, answered the questions the researchers had, as well as took part in a discussion concerning the possibilities for modeling the success of the services. Five researchers took detailed notes during the workshop. After the workshop, the notes were combined.

To get another point of view to the safety measurement process, we collected data by contacting the customer organisations of Buildercom who are currently using the above-mentioned service in their work. We collected data from the users of the service through one group discussion and one interview at the construction company. The participants in the group discussion were the business field manager and the product manager from Buildercom, and the site supervisor of the construction site from the customer company. In the interview, the participant was the site supervisor of another construction site. In addition, data was gathered through observing three users using the mobile service in their work in two different construction sites. The interviews and observations were recorded and later transcribed for data analysis. The observations were conducted by two researchers who followed the safety measurement process done by an industrial safety delegate and a site supervisor.

After gaining a comprehensive view of the business processes affected by and the usability issues related to the use of the mobile service, we modeled the process with MoBiS-UML. The model was presented to the representatives of Buildercom in another workshop. The model was further developed by taking into account the feedback from the workshop. For example, more phases and actors were included into the model.

The third workshop was run in December 2006. The models of MoBiS-UML were presented to representatives of the project partners from different industry fields (software company, service provider, manufacturer of mobile devices). The overall comments were very encouraging. All the participants valued the visual representation of the process and the fact that usability observations could be

integrated to the model easily. The participants also pointed out that in the marketing situation the modeling should be fast and simple and this have been taken into account.

In the next section, the safety measurement process and its modeling is introduced in more detail.

Modeling Work Processes with MoBiS-UML

Process models are the basis of successful businesses (*e.g.*, Eriksson & Penker 2000). To design successful mobile services, MoBiS-UML combines business process modeling with mobility and usability requirements. MoBiS-UML is a method not only for developers, but also for marketing people and decision-makers. It helps to develop mobile services that better support the user's mobile tasks and work processes. MoBiS-UML also helps in the marketing of a new mobile service by making comparisons between the customer's current process (as-is) and the potential process with the mobile service (to-be) possible. The benefits for business managers are that MoBiS-UML highlights, for example, the time savings the mobile service can produce. In addition to the process models for the as-is and to-be processes, we provide a method for adding usability observations to the MoBiS-UML models. This helps the developers understand the causes and effects of the usability problems.

This section illustrates the use of MoBiS-UML in the modeling of the safety measurement process at construction sites.

The Notation of the MoBiS-UML

MoBiS-UML models business processes that are supported by mobile services or mobile work processes that could benefit the use of mobile business services. As mentioned above, our modeling method of choice was UML Sequence Diagram. Originally, Sequence Diagrams have been developed to aid software developers understand the messages that different actors (*e.g.*, classes or objects in object-oriented programming) send to each other. For our purposes, this information is too detailed as we do not aim at providing specifications for the purpose of programming. Instead, we aim at modeling the work process where the actors are people, systems, or organizations playing a role in the process.

The notation of MoBiS-UML is slightly modified from the traditional notation used in Sequence Diagrams. The frequencies of some essential actions are shown in the diagram using cardinalities/multiplicity (used in UML Class Diagram to present the amounts related to objects). The frequencies are written in brackets [] after the name of each action, making it easy to see how often they are performed. If there are even small problems with the actions that are performed several times a day, they are important to resolve.

The actors in the model may be humans, devices or information systems. To identify these actors, different colors or symbols can be used. The information on the type of actors is needed in the design phase of the mobile service. It may be especially beneficial to automate repetitive or error-prone tasks that are currently performed by humans.

To make the problems visible in the process, we propose attaching explanations of usability gaps and other problems with notes to the diagram. The notes are anchored to the interaction they relate to. In our examples, we also added other important observations to the interactions even though they were not always usability problems.

The Work Process Modeling Phases

We propose having two different models when designing a novel mobile business service: an *as-is process model* (the work process that the mobile service is intended to support), and a *to-be process model* (the goal state for the design where the mobile service supports the work tasks to the extent possible). The different phases in the modeling with MoBiS-UML are presented in Figure 1. It should be noted that the steps described in this process closely resemble the steps that can be found in several different human-centered or participatory design processes (e.g., MacKay, 2004; ISO 13407, 1999). Our aim is not to propose a completely novel process for designing mobile services, but rather, show how the models we are proposing fit to the common steps of user-centered design.

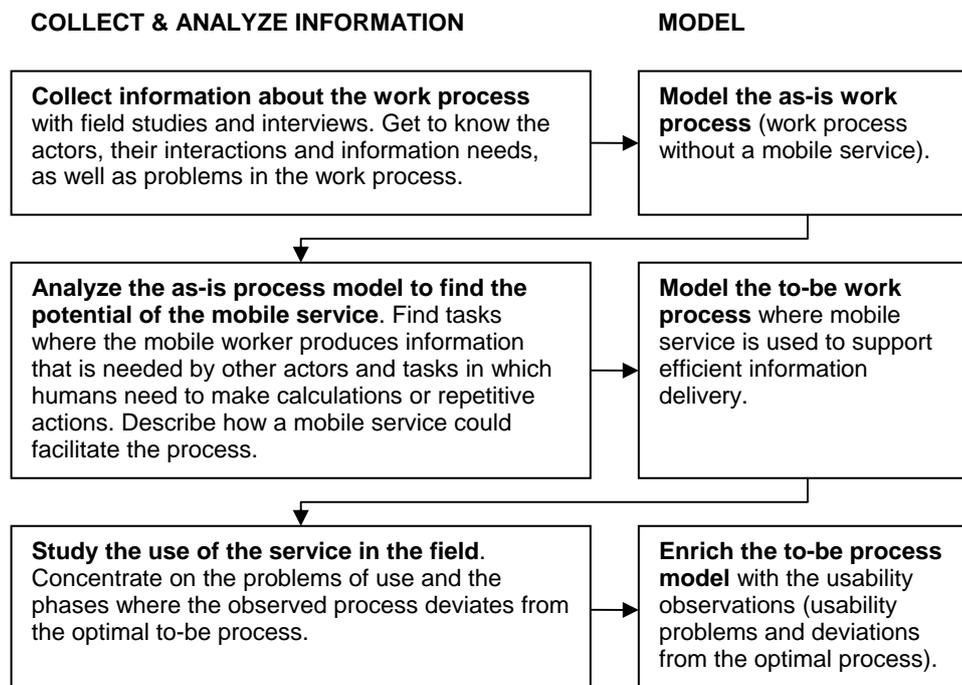


Figure 1: Different phases in the modeling of mobile business processes with MoBiS-UML.

Next, these different phases are discussed in detail through a case study.

How to Model the As-is Process with MoBiS-UML?

This section presents our guidelines for modeling work processes with MoBiS-UML along with examples (in italics) of how the different guidelines were implemented in our case study.

Study the business process and collect information about the as-is work process. There are many different methods to use in this phase, but we encourage using methods that provide as much direct information from the work process (e.g., observing workers) and the overall business process where the work is performed (e.g., interviewing managers).

To gain a deep understanding on the TR-measurement process, we conducted interviews, observations, and three workshops where the participants represented different stakeholders (see Section Methods). These methods provided the raw data for the as-is process model.

Describe the as-is process in textual form. In this phase, it is beneficial to describe the work process in as much detail as possible. The details help to understand all the phases of the process that are currently cumbersome and find the phases where the mobile service could help. The problems observed in the process are also described in this phase.

In our case study, the industrial safety delegate makes safety observations and the site supervisor scores them in the paper form as “correct” (e.g., work environment is clean) or “not correct” (e.g., an employee has no helmet on) according to safety requirements. The frequency of observations is marked along with detailed descriptions of the problems (what is the exact problem, its location, the person/organization responsible for correcting the problem). In the case of critical problems, the industrial safety delegate may leave a piece of paper to the location of the problem to make sure that the problem is acted on as soon as someone enters the location.

After the measurement round, the observer calculates “TR index” on the basis of the markings in the form (calculator is used to help in the process) and reports the index in the same form. The completed form is signed by the industrial safety delegate and the site supervisor. Following that, the form is copied: one copy of the form will be put in the notice board at the construction site and one is given to the responsible supervisor. The original form is filed. Information about the correction of problems is transferred via different means. In some construction sites, the constructor tells about the corrected problem to the site supervisor; but sometimes the information about the corrected problems is not communicated at all. In these cases, the site supervisor may notice problems being corrected when s/he is performing other work tasks at the construction site.

Find the actors. The process modeling starts by finding the actors from the textual description. The actors are set horizontally in the upper part of the diagram. It is beneficial to place the actors that communicate the most near each other. We differentiated human and non-human actors using different colors, but symbols could be used, as well. If the actor does not need to perform actions that are related to the process being modeled while on the move (out of office) this information should be written below the name of the actor. We have used the term 'stationary' for this. The actor's block (shown vertically in the diagram) shows when the actor is active (interacts with other actors); when the activity ends, the block ends as well.

From the textual description of the process, we found actors like industrial safety delegate, site supervisor, calculator, and copier. The way these actors and their type and state appear in the diagram can be seen from Figure 2.

Find the interactions between actors. The names of the interactions should be descriptive; the name can be an action or an artifact. When describing actions, we recommend using an active form (e.g., *industrial safety delegate reads and signs the report*). If the interaction is automatic (the system sends information automatically), the arrow begins from the actor who sends the information. As the order of interactions proceeds from up to down the vertical proximity of the interactions can be used to simulate the time between them. This procedure helps to visually estimate the relative time for the tasks in the context of the whole process. In some cases, it may even be possible to exactly time the process and mark the running time on the Y axis.

Add the frequencies. Frequencies are added after the name of the interaction, as in UML notation.

In Figure 2, industrial safety delegate makes observations once or more often and site supervisor calculates the number of observations once.

Add the problems of the process to the interactions. Describe the problems that were observed in the detailed description of the process. Try to keep the problem descriptions short, but aim at making them detailed enough to make them understandable from this explanation alone.

In Figure 2, site supervisor calculates the number of observations - this process is error-prone.

Figure 2 shows a part of the MoBiS-UML model of the as-is process described above. It should be noted that the model could be made even more detailed. For example, the model could show all the different actions of the site supervisor when marking the observations in the TR-measurement form. The needed level or detail is depended on the intended use of the model – if a totally new service concept is being designed, low-level actions may not be necessary, whereas for the design of a user interface that is likely to follow the interaction steps in the current process, it is important to model all the actions. The level of detail shown

in this paper was intended to give a good understanding of the process without cluttering the model with all the low-level actions.

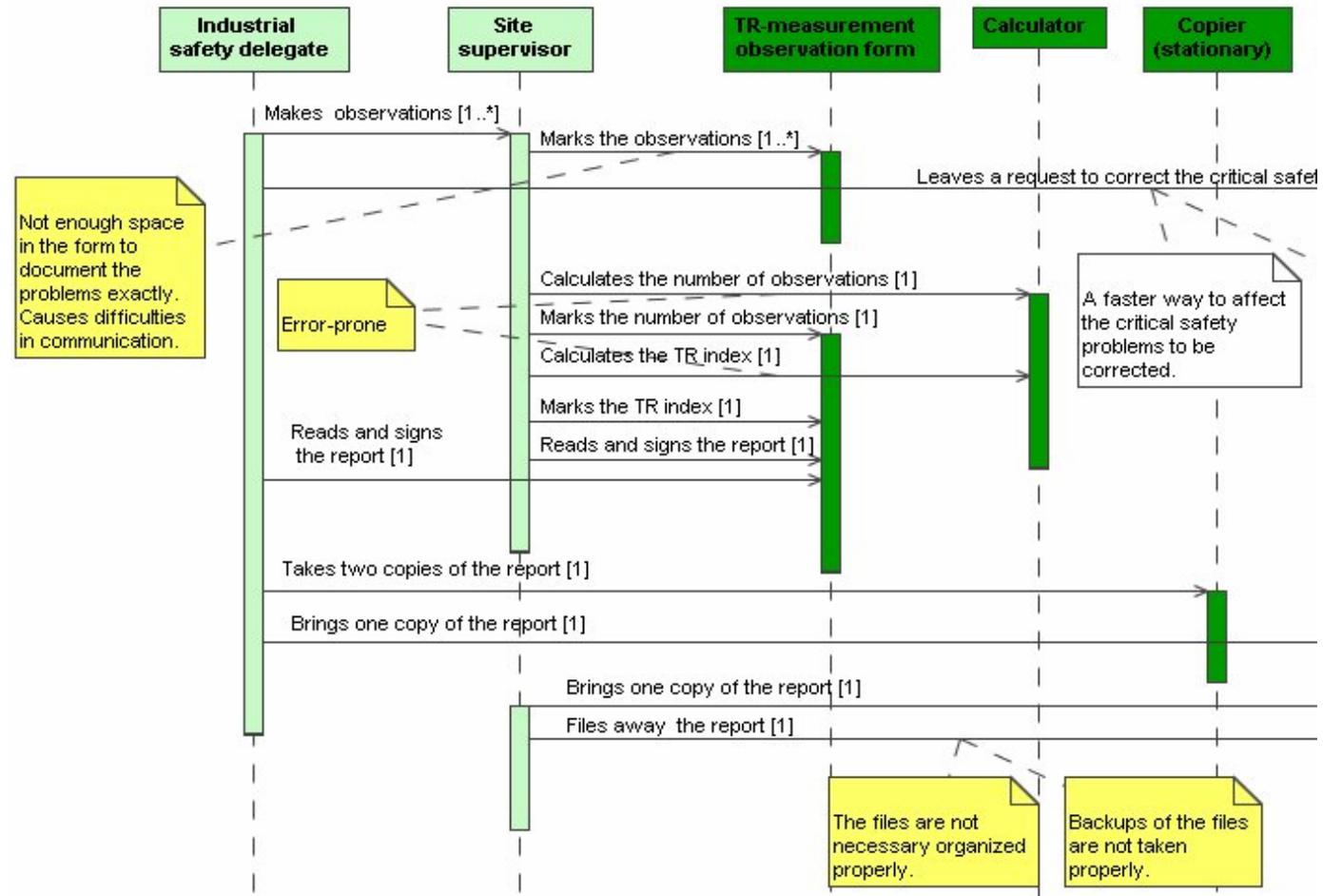


Figure 2: A part of the current (as-is) TR-measurement process model.

From As-is Process Model to To-be Process Model

As-is and to-be processes have different roles in the mobile service development. The *as-is process model* is the basis for the design of the mobile service. In our case study, the as-is model showed several problematic phases in the process. For example, in the measurement phase, the form used for the TR-measurement has very little room for the details of the problem and thus, the descriptions are often scarce. Added with the problems in interpreting handwriting and the varying ways of describing the problem, its location and the people responsible for correcting the problem, the consequence may well be that the problem is not corrected at all. In communicating the results of the TR-measurement to different stakeholders, the process is somewhat undetermined. The information concerning the corrected safety problems is not always documented and paper copies of the TR-measurement form are sent to different stakeholders although they would benefit from getting the information in digital form.

From the as-is process model, it is straightforward to see that a mobile service could improve the measurement phase by facilitating the inputting of information. For example, problems, locations of problems, and actors responsible for correcting the problems could be selected from a list of options instead of free-form text. In addition, camera-phones can be used to take photographs of the problems decreasing the need for a detailed description; the photographs can also be useful for documenting changing situations, such as an employee working in a hydraulic lifting platform without the safety gate.

In general, different kinds of tasks from the as-is process model are considered as candidates for mobilization, for example,

- tasks where the worker, while out of office, produces information that is needed by other actors in the process (either in or out of an office),
- the actor has information that needs to be communicated to someone immediately (such as safety risks), and
- tasks in which humans need to make calculations or repetitive actions.

The greatest benefit from the mobile service can be obtained in the phase where the results of the TR-measurement need to be communicated to the different stakeholders. In this phase, the mobile service can automatically send the report to the database and the different stakeholders can retrieve the information from the database when and where needed. In TR-measurement, the speed of information transfer is important: if information is mediated quickly to the person/organization who can respond to the problem, accidents or even deaths can possibly be prevented.

The *to-be process model* is created by following the guidelines given above with the goal of optimizing the process. The to-be process model illustrates the *optimal*

process with the mobile service and thus, problems are not included in the model. This model mainly benefits the marketing people, allowing them to demonstrate the potential benefits of the mobile service to customers. Although the optimal process is the goal, the actual use of the mobile service in the field may differ from it. It is possible that not all tasks are performed with the mobile service which results in the benefits for the complete process to be smaller than anticipated.

Enriching the To-be Process with Usability Observations

In addition to the as-is and to-be process models, our modeling approach can be used to support the further development of the service with an *observed mobile process model*. For the observed model, the to-be process model is used as the background and the problems of use are simply integrated on top of it.

Figure 3 shows how the *observed mobile process* differed from the to-be process in our case study. The problems were found in the field studies where the users of the service prototype were observed while performing the TR-measurement or interviewed about their experiences in using the service.

The observed process highlights the problems in the use of the mobile service or service prototype in real work environment and thus, sets targets for the development of the service. In addition, we claim that this approach for communicating the usability problems and other observations yields in a good understanding of the problems and actors who are involved with or affected by the problems. Often in the usability evaluation reports, the problems are reported in a highly detailed manner, but the wider process where the system was used when the problem occurred is often given less attention.

In the case of the TR-measurement, some problems were related to the service (*e.g.*, the TR-measurement being distracted by incoming calls), handheld device (*e.g.*, small keys that make inputting of information difficult), or the functioning of the network connections (*e.g.*, connection lost at certain locations). For example, small keys in the mobile phones were experienced as problematic when used at construction sites during the winter-time with gloves. Thus, the service should decrease the amount of information to be inputted with the device to the extent possible.

In the present case, the problems with inputting information caused the service to be used sub-optimally: the workers sometimes omitted essential information because of the troubles of inputting text.

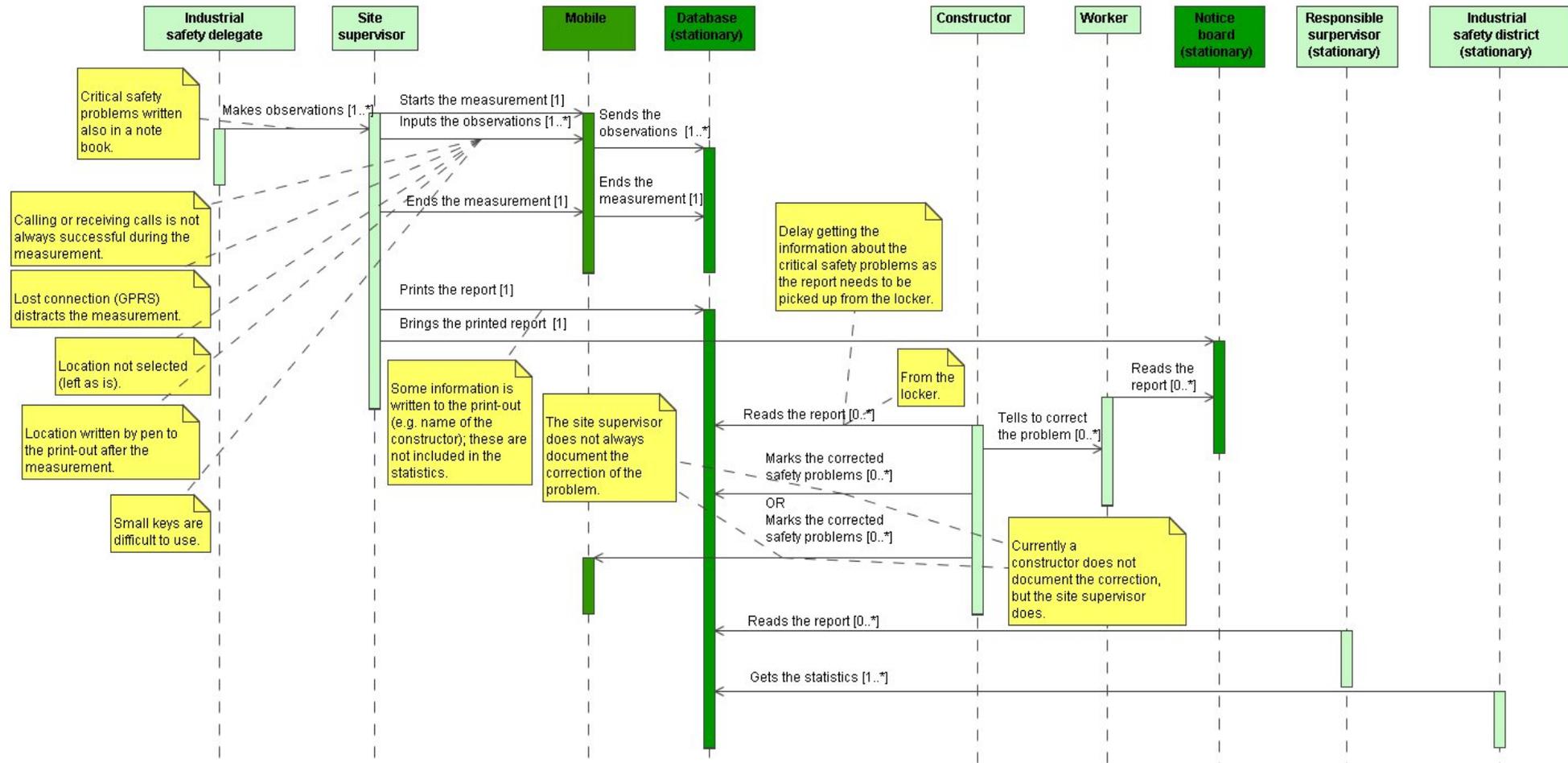


Figure 3: The model of the observed mobile TR-measurement process.

To aid the service developers analyze the problems found in the observed mobile process, we prepared a set of questions (

Table 1) that encourage the developers to think about the reasons behind the problems, their effects on business performance, and ideas for improvement. After analyzing the problems with the help of this table, the service developers should have a clear understanding about the problems in the use of the mobile service, their reasons and the ways to overcome these problems through design decisions.

Table 1 presents an analysis of two of the problems presented in Figure 3.

Table 1: Questions to aid in the analysis of the consequences and the priority of the observed deviations from the optimal process.

Observation (deviation from the optimal process)	What are reasons for the observed behavior?	Why is this a problem?	What is the effect of a problem on business performance	Ideas for improvement
The correct location is not selected from the list in the mobile device; sometimes the location is marked to the print-out by hand.	Deep hierarchies make it troublesome to navigate to the correct location. The correct location is not always available. Small keys are difficult to use.	Safety observations documented to the wrong location → correcting the problem difficult as it may not be found.	If the problem is not found and corrected, the risk of accidents increases. In case of an accident → high costs, weakening of the company's image on work safety	GPS could be used for approximate locating. Easier entry of the location information may make the information more accurate?
Delay in getting information about the critical safety problems .	Constructors should go to a physical locker to get the report, which is not necessarily done every day.	Correcting the problem is delayed.	The risk of accidents increases: accidents are expensive and weaken the company's image on work safety.	Critical problems should be immediately communicated to the constructor by MMS or E-mail.

The observed usability problems can be prioritized according to their effect on business performance at least three ways. For example, *critical problems* imply safety risks, cause the work-process to slow down markedly, cause the user expressing negative attitudes towards the whole service, or make the customers frequently contact the customer-service. *Major problems* imply that the service is not used as intended and as a result, important benefits of the service are not realized, the use of the service does not result in increases in efficiency where expected, or the issue causes several contacts to customer service. Finally, *minor problems* refer to the service used differently than the optimal process predicts, but this difference does not cause the efficiency of work to suffer, or the user feels that the issue does not hinder his/her work task.

Conclusions

This paper presented our approach for studying the benefits of mobile business services through MoBiS-UML — UML sequence models specifically modified for the purpose of developing mobile business services. The use of MoBiS-UML was demonstrated through a case study on safety measurement process at construction sites. Our goal was to develop a modeling method that is easy to learn, is appropriate for different users, supports different phases of the service development, and emphasizes the impact of the context of use.

When analyzing the potential of mobile services for facilitating business processes, it is important to clearly understand how the work proceeds step-by-step and who the actors in the process are — Sequence Diagrams support these requirements well. In addition, the clear ordering of actions in Sequence Diagrams makes it easy to add the problems occurring in the specific phases of the process and the factors related to the context of use to the model. To make it easy for others to employ MoBiS-UML, we presented step-by-step guidelines along with concrete examples of the modeling process.

The models can be used to illustrate the usability and other problems both in the as-is process where mobile service is not used and in the observed mobile process where the mobile service or service prototypes are used in the field. Furthermore, the models can be used as the basis for calculating the financial potential of the mobile service by comparing the time and other resources needed in the as-is and to-be processes.

When developing a completely new type of a service, information systems are not necessarily used in the current work process at all. In this situation, the *as-is process model* provides a deep understanding on the work process and the goals of the work. This understanding, in turn, provides crucial information for the designers of the novel service by giving answers to the following questions:

- *what* information is needed,
- *when* the information is needed,
- *who* needs the information,
- *what is critical information* in the work process.

When the design is based on this deep understanding of the underlying process, the new service's likelihood of success is expected to be markedly higher than if the design is based on intuition only.

The *observed* process model highlights the targets for the further development of the service. According to our experience and other studies (*e.g.*, Schierholz *et al.*, 2006), it is difficult for the users to accurately report the problems using the service with questionnaires or interviews. Therefore, observational methods need to be used to gather this kind of information from the users. We suggest using field studies, where the use of the service is observed in the real context of use. Some of the problems may be related to factors that are outside of the service user

interface (cold fingers, no telecommunication network available) or the problems may be usability problems directly related to the user interface (*e.g.*, hard to find information, information is missing). In both of these cases, solid understanding of the work process gives a good framework for thinking about the solutions for the problems—some of which may require only small modifications to the interface whereas others may require the service logic to be significantly modified.

Thus far, we have used MoBiS-UML for modeling two different *mobile* work processes—the TR-measurement presented in this paper and a process where the mobile business service is used for dispatching taxis. Being a relatively general modeling method, MoBiS-UML does not necessarily need to be limited to the modeling of *mobile* services only. However, we expect the benefits of this modeling method to be more pronounced in the mobile context as the method specifically emphasizes the characteristics of mobile work (*e.g.*, stationary and mobile actors), the impact the context of use has to the process, as well as the changes in the work process due to the introduction of a mobile service.

In accordance with earlier studies, we also noticed that UML was a simple and understandable way to model mobile work processes also for less technically oriented people. The modified sequence diagram was found to be an appropriate way to describe interactions between different mobile and stationary actors; usability problems and other observations were also easy to add to the model with notes.

The case study and the modeling approach presented in this paper were completed during the first quarter of a two-year research and industrial cooperation project, MOMENTO (MOMENTO, 2007). During the remainder of the MOMENTO project, the goal is to collect more data concerning the usefulness of this modeling approach for the intended users of the models. To further enhance the usefulness of MoBiS-UML, we are developing a tool that helps to compare the financial effects of the as-is and to-be mobile processes.

Acknowledgments

The authors would like to thank those who have supported this work with their contributions. Special thanks for Juha Aspinen, and Kaisa Väänänen-Vainio-Mattila as well as for Tekes (Finnish Funding Agency for Technology and Innovation).

References

- Aversano, L., & Canfora, G. (2002). "Introducing eServices in Business Process Models", in *Proceedings of the 14th international conference on Software engineering and knowledge engineering 2002*. 481 – 488.
- Buildercom (2007) Buildercom Ltd. homepages. Retrived March 27, 2007, from <http://www.buildercom.fi>.
- Card, S. K., Newell, A. & Moran, T. P. (1983). *The Psychology of Human-Computer Interaction*. Lawrence Erlbaum Associates, Inc.
- Davenport, T.H. (1993). *Process Innovation: Reengineering Work through Information Technology*. Boston, MA: Harvard Business School Press.
- Davenport, T.H., and Beers, M.C. (1995). "Managing Information about Processes", *Journal of Management Information Systems*, vol.12 , no. 1, 57-80.
- Davern, M.J. & Kauffman, R.J. (2000). "Discovering Potential and Realizing Value from Information Technology Investments", *Journal of Management Information Systems*, vol. 16, no. 4, 121-143.
- Dix, A., Finlay, J., Abowd, G.D. & Beale, R. (2004). *Human-Computer Interaction*. Third Edition. Prentice Hall.
- Dobing, B. & Parsons, J. (2006). "How UML is used", *Communications of the ACM*, vol. 49, no. 5, 109-113.
- Eriksson, H-E. & Penker, M. (2000). *Business Modeling with UML: Business Patterns at Work*. Canada: John Wiley & Sons.
- Heppner, C.C., Kates, J., Lynch, J.S., & Moritz, R.R. (2005). "At Sprint, understanding the language of business gives usability a positive net present value", in R.G. Bias and D.J. Mayhew (eds.) *Cost-justifying usability*, pp. 601-611, Academic Press, Boston.
- ISO 13407:1999. Human-centred design processes for interactive systems.
- ISO 9241-11 (1998) *Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability*. Geneve: International Organization for Standardization.
- Johansson, N., Lind, T. & Sandblad, B. (2006). "Usability in IT Systems for Mobile Work", in Andriessen, J.H.E. & Vartiainen, M. (eds.), *Mobile Virtual Work – A New Paradigm?* pp. 177 – 202. Springer, Germany.
- Kadyte, V. (2005). "A Case Study on Mobilizing Business Process", 18th Bled eConference 2005 eIntergration in Action, Slovenia 2005.
- Kujala, S. (2002). "*User Studies: A Practical Approach to User Involvement for Gathering User Needs and Requirements*", Acta Polytechnica Scandinavica, Mathematics and Computing Series No. 116, the Finnish Academies of Technology, Espoo.
- Laitinen H., Marjamäki M., & Päiväranta K. (1999). "The validity of the TR safety observation method on building construction", *Accident Analysis and Prevention*, vol. 31, no. 5, 463 – 472.
- Lee, I. (2004). "Evaluating business process-integrated information technology investment", *Business Process Management Journal*, vol. 10, no. 2, 214-233.
- Mackay, W.E. (2004). "The Interactive Thread: Exploring Methods for Multi-disciplinary Design", in *Proceedings of the 2004 Conference on Designing interactive Systems: Processes, Practices, Methods, and Techniques*. DIS '04. New York, NY: ACM Press, pp. 103-112.

- Marcus, A. (2005). "User interface design's return on investment: examples and statistics", in R.G. Bias and D.J. Mayhew (Eds), *Cost-justifying usability*, pp. 17-39, Academic Press, Boston.
- Markova, M., Aula, A., Lönnqvist, A., & Wigelius, H. (forthcoming) "Identifying and measuring the success factors of mobile business services." *International Journal of Knowledge Management Studies*.
- MOMENTO. (2007). The homepage of MOMENTO project. Retrieved January 5, 2007, from <http://www.cs.tut.fi/ihte/projects/momento>.
- Mori, G., Paterno, F., & Santoro, C. (2002) "CTTE: Support for Developing and Analyzing Task Models for Interactive System Design", *Software Engineering, IEEE Transactions on* vol. 28, no. 8, 797 – 813.
- Phillips, M.D., Bashinski, H.S., Ammerman, H.L. & Fligg, C.M. Jr. (1998). "A Task Analytic Approach to Dialogue Design", in Helander, M. (Ed.), *Handbook of Human-Computer Interaction*, pp. 835-857. Elsevier Science Publishers B.V, Amsterdam.
- Schierholz R., Kolbe L.M. & Brenner W. (2006). "Mobilizing Customer Relationship Management – A Journey from Strategy to System Design", in *Proceedings of the 39th Hawaii International Conference on System Sciences*.
- Sheng, H., Nah, F., & Siau, K. (2005). "Strategic implications of mobile technology: A case study using Value-Focused Thinking", *The Journal of Strategic Information Systems*, vol. 14, no. 3, 1402-1408.
- Tam, A.S.M., Chu, L.K., & Sculli, D. (2001). "Business process modeling in small- to medium-sized enterprises", *Industrial Management & Data Systems*, vol. 101, no. 4, 144-152.
- Valiente P. & van der Heijden, H. (2002). *A Method to identify opportunities for mobile business processes*. SSE/EFI Working Paper Series in Business Administration, No 2002:10, August 2002.
- Verburg, R.M., Testa, S., Hyrkkänen, U., & Johansson, N. (2006). "Case descriptions of mobile virtual work in practice", in Andriessen, J.H.E., & Vartiainen, M. (eds.) *Mobile virtual work* pp. 267-288. Springer, Heidelberg.
- Virine L. (2003). "Visualization of probabilistic business models", in S. Chick, P.J. Sánchez, D. Ferrin, & D.J. Morrice (eds.), *Proceedings of the 2003 Winter Simulation Conference*, pp. 1779-1786.
- Yuan, Y. & Zheng, W. (2005). "From Stationary Work Support to Mobile Work Support: A Theoretical Framework", in *Proceedings of the International Conference on Mobile Business (ICMB'05)*, 1-7.

Service Oriented Architecture for Health Information Systems in Africa: Issues, Literature and Systems Survey, and Research Directions

Boniface Kabaso

Cape Peninsula University of Technology, Western Cape, South Africa

kabasob@cput.ac.za

Abstract.

A number of many medical information systems deployed today across Africa are not able to interoperate in order to communicate and exchange common data. Even the new ones that are introduced to deal with new challenges are not able to make use of the information housed in old systems.

This work aims at studying what Service Oriented Architecture (SOA) can offer to health information systems in Africa, and how it can be introduced to existing systems. SOA offers to bring better interoperability of systems deployed and reusability of existing IT assets.

This study is work in progress. The approach used involves the collection of information from two sources. The first is about existing Health Information systems in Africa and the second about the use of SOA globally in healthcare. Information will be collected from literature and a few selected deployed systems that are available for analysis.

This paper introduces the current state of Information Management systems and its problems, particularly in South Africa. It states why a single system will not be an appropriate solution, explains what Service Oriented Architecture is and what benefits it can bring to interoperability and reusability problems.

.Keywords. eHealth, Interoperability, Service Oriented Architecture, Health Information Systems.

Introduction

Most health institutions worldwide are in the core business of providing health care to patients. Patients, over the course of their life, visit several health institutions and their medical records are captured and stored either on paper based or digital electronic systems. For an institution to provide good continuity of care to its patients, it needs a fast, easy and 360 degrees view into a patient's complete medical history. However, the records that make up this history are scattered around several institutions that the patient has visited in his or her life time and getting to this information is a great challenge particularly if most of the information is in paper based systems. The good news is that most institutions today have realised the need to digitize medical records and efforts are under way in most countries funded by vendors, donors and national governments. (Hamish et al , 2005)

Despite this mass migration to digital systems, the problem of accessing patient records across departments, institutions, regional or international boundaries still remains a problem to be solved. Today, the health institution computing environment is very heterogeneous and complex. Most electronic records are kept in various types of digital systems ranging from flat files to databases based on home grown or off the self systems. Most of these systems have technologies that are local, proprietary and insular. They are not designed to communicate with other systems whether inside or outside individual health institutions. Their primary design is to capture and store patient records for local analysis.

Today there is a realisation of the importance of sharing clinical information. Information coordination within an institution and across various health institutions is essential in ensuring that care providers work together effectively to support integrated care initiatives that deliver the best levels of service and efficiency (Dag et al, 2006). At this stage, in order to streamline and coordinate access to this information and eliminate the interoperability barriers, it's not practical to either discard the existing systems or migrate to the new systems. Currently, the deployed systems have an enormous amount of data stored across disparate pieces of software. Most of the health institutions have made extensive investments in these system resources over the course of many years. The solution to these issues must capitalise on the investments made in the existing old systems. The big question asked world wide is how this can be done in a cost-effective way.

It's more practical and cost-effective to evolve and enhance these deployed systems than rip and replace them. Service Oriented Architecture (SOA) provides a cost-effective solution. SOA is emerging as the premier integration and

architecture framework in today's complex and heterogeneous computing environment. SOA applications stretch across infrastructure tiers, software, middleware, and operating systems—even institution, regional or national borders (Boris et al, 2003).

Background

Lately, Africa has been seeing a steady increase in the Information and Communication Technology (ICT) systems deployed in health institutions. This is evidenced by the funding that has been going into the health information systems from both the government and the donor organisations. Large numbers of national and international agencies, research organisation, NGOs etc continue to carry out studies and develop systems and procedures to exploit the power of ICT in public and private health institutions (Koos et al, 2002).

In South Africa, in 2002, the study conducted by the department of trade and industry on the diffusion of ICT in the health sector found that various ICT initiatives were in place in most health institutions with several systems deployed. (Koos et al, 2002). By 2004, the major systems that were developed and implemented in hospitals across the country include the following:

- District Health Information System (DHIS) (<http://www.hisp.org/>)
- Patient Administration and Billing (PAAB) (http://www.doh.gov.za/department/clus_hinfo.htm)
- Medicom (<http://www.medicomsoft.com>)
- Delta9 (www.ethniks.co.za/unicaremain.htm)
- Systech (<http://www.healthsystems.co.za>)
- Oasis (<http://ehr.co.za/main.php>)
- Meditech(<http://www.meditech.co.za>).

Furthermore, in support of this increase in ICT activities, in March, 2006, the Western Cape Province (WCP) department of health launched a primary Health Care Information System at 13 community health centers in the province (Mark.H, 2006). The aim of the system is to have a single centralized system that can be used across all facilities in province. WCP has made a lot of effort in managing to integrate various systems that are in the province using flat files and web services.

However, on a large scale, like in most parts of Africa, most of the systems installed do not have the means to connect to each other and later on exchange any information. Most of these systems run on different hardware, operating systems and network infrastructure. Even the programming languages used is

different and this in turn makes the process of talking to each other a huge challenge. In fact, some of the health institutions have multiple systems in their ICT assets that do not talk to each other. Mthatha General Hospital in Eastern Cape Province is the case in point. They have DHIS system for the main clinical activities and a separate application for HIV/Aids patients. And these two systems basically duplicate patient's demographic information because they can not exchange data.

These problems have been recognized by several studies and attempts to provide solutions to this problem have been made (Dogac et al, 2006). One of the solutions most taunted for this problem is to have one type of distributed system deployed across the network infrastructure. In fact, most of the software vendors of systems already deployed market their products with a pitch that it will be the system that will be deployed across the whole network to provide the one "stop shop" for electronic health records. For example the DHIS development team proposes finding means to format data from other systems before it is populated into DHIS as one of the solutions to solving the problem of different systems on the ground (Bra et al, 2007).

The single grand system approach has two key problems. First it has a potential of leading to a monopoly. There is enough evidence that monopolies largely benefit vendors. Since there is no competition, the quality of service and innovation to improve the service tends to degrade over a period of time. Secondly, reality clearly suggests that this approach is not feasible. There are systems already in some places that are doing the required work by health institutions. Asking these institutions to throw away their good systems that have served them well and embrace the new universal system is not only impractical, but also costly.

In 1998, the Department of Health in South Africa published a tender to provide a national health information system (www.doh.gov.za/nhis/docs/nchmis.htm). However, it was later withdrawn after realizing that each province was at different stage. Instead each province was been allowed to select its own systems, within an agreed framework. Indeed, this has increased the number of systems that do not interoperate because there was no architectural framework the provinces were supposed to follow. In 2006, the department of health made a second tender to find a vendor who would provide a solution that will harmonise all the various systems deployed across provinces. At the time of this writing, the tender documents were with the recommendation committee to select the vendor who will consolidate the health system in South Africa.

This work in progress aims at finding solutions that would address the problems of interoperability and reusability discussed above. The work aims to propose a

solution that uses a Services Oriented Architecture (SOA) to address these issues without having to replace the systems that are already in place. The work would produce a proposal for a migration path to SOA architecture for the deployed systems. The work will also propose a set of Application Programming Interfaces (API) to promote the building of SOA based architectures conforming to the open standards for electronic health records in Africa. These APIs will be used for the building of new systems.

Motivation

Before discussing the motivation behind this work, it is appropriate to first discuss the meaning of SOA in the context of a health care industry and briefly talk about the technologies that support SOA.

According to the OASIS Group, SOA is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectation. (OASIS, 2006)

In the health care context, health institutions, which represent ownership domain, create capabilities to solve or support a solution for the problems they face in the course of running their institution operations. Capabilities can be locally owned by the institution or under the control of another institution like a specialist laboratory. These capabilities, located at one or various places, can be combined to provide what is known as a service. In SOA, services are essentially the mechanism by which needs and capabilities are brought together (OASIS, 2006).

SOA goals, as a general principal, have been around for many years. A number of technologies, like Common Object Request Broker Architecture (CORBA), Distributed Component Object Model (DCOM) and Java Remote Method Invocation (RMI) have attempted to realize them. Although it is clear that these technologies were promising, they failed because of vendors adapting proprietary implementation of the ideas. Further, these technologies (CORBA, DCOM, RMI, etc) depend on specific binary protocols that internet firewalls, by default, are configured to block. They tend mostly to work well within a Local Area Network (LAN). Deploying these technologies over the public internet is a non-trivial mission. It needs special firewalls or gateways.

In the last ten years, we have witnessed the development and maturation of several key enabling technologies such as the Internet and XML. These technologies have provided the foundation for a new technology called web services. A web service is a piece of software that conforms to a set of

interoperability standards. These standards enable global interoperation of computers regardless of hardware platform, operating systems, network infrastructure or programming language. Web services depend on three interrelated XML-based software standards to work. These are Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal, Discovery, Description and Integration (UDDI).

SOAP is a standard based messaging format written in XML(www.w3.org). Every SOAP message follows a pattern that has been specified by the W3C standards. Basically web services exchange SOAP messages, over a variety of protocols such as HTTP or SMTP. WSDL is an XML document designed according to standards specified by W3C too (www.w3.org). WSDL allows a particular web service to describe itself to the outside world. It provides the potential user or consumer of that service with the explanation of how a service works and how to access it. The WSDL also describes how to create a SOAP request that will invoke that particular web service. Because of the capability of WSDL, web services are known as self-describing software elements. By reading the WSDL, anybody can generate SOAP messages to pass to the web service described in the WSDL. UDDI is a listing of web services available within a particular network (www.w3.org). Potential web services consumers can look up web services that are available for use through the UDDI. UDDI is important because it bring network transparency to the network. Network transparence refers to the ability of a web service to be active anywhere on any network, or group of network without having any impact on its ability to function. Because each web service has its own address, web services have similar flexibility to websites on the internet. A web service can be located on any computer that is connected to the network and communicates using internet protocols. UDDI facilitates the web service discovery and location.

Web services are one effective way to create a SOA because the infrastructure and standards that support this technology are finally in place to make web services based SOA practical. Please note that SOA is not equal to web services. It can be implemented using other technologies with much difficulty. The big motivation for a web services based SOA is that the infrastructure is now in place. We now have the infrastructure to that gives us new ways to create, manage, share, and secure applications. By creating connections among disparate applications not previously possible due to their inherent incompatibility, the SOA approach can help institutions increase the flexibility of their clinical processes, strengthen their underlying IT infrastructure, and retain and reuse the IT services they've already deployed. These connections can allow a complete clinical process to be linked to the exact IT components needed to execute the processes. Further, these connections can be mixed, matched, and reused to address problems unique to

individual institutions, and since they are based on industry standards, services connected in this way can also be shared with other various institutions.

Additionally, within an institution, using SOA to connect information from disparate medical systems can give caregivers secure, single sign-on to access multiple applications, including lab reports, medical imaging, scheduling and other critical information about a patient. Since it integrates and synchronizes all patient information from disparate applications, patient safety and clinical efficiency can be increased dramatically.

Significance of the Study

The health care environment is very complex. The core problem at the heart of this work is interoperability of various IT assets in and outside an institution. Interoperability, using open standards to support information and data exchange, has become a very significant issue for health information technology developers and implementers. It is big concern of all national governments implementing or promoting the implementation of national health information networks and infrastructures.

To achieve interoperability, there are many aspects of the situation on the ground that needs to be investigated and understood if a solution of real interoperability is to be proposed. According to the National Alliance for Health Information Technology (NAHIT, USA) interoperability in health care is defined as the ability of different information technology systems and software applications to communicate, exchange data accurately, effectively, and consistently, and to use the information that has been exchanged.

This definition clearly states that there are two sides to interoperability, that is, syntactic (structure) and semantic (meaning). Syntactic interoperability provides the means for the two parties to communicate through the wires and bits. It guarantees the exchange of the structure of the messages, but carries no assurance that the meaning of the message will be decoded and used correctly. This assurance is provided by the semantic interoperability. Semantic interoperability ensures that the exchanged message has meaning to both parties and can be sensibly used.

Furthermore, this interoperability definition further fits into the concepts for a service as described by the OASIS SOA reference Model (OASIS, 2006). The model describes two parties for communication to take place, namely a service consumer and a service provider. The two concepts involved in the interacting with services are the ability of both parties to see and interact with each other, and the ability of one party to make the other produce a real world effect. The real

world effect should be something that makes sense to both parties and for this to take place, the exchanged messages must carry meaning that both parties understand.

The semantic interoperability is the most challenging in the healthcare space because of the many competing standards used by the deployed systems. Standards range from the widely used ones like HL7, ICD-10 to proprietary ones. The significance of this study is to collect from the literature and the deployed systems the standards that are used for message storage and transfer. This information will be crucial in developing the API that will go into the components or interfaces to be used in the Enterprise Service Bus (ESB). The ESB, described as a process model in the OASIS SOA reference model, will be used as a semantic mediation medium. Integration of data from heterogeneous sources will be done through semantic mediation. This mediation will be used to convert healthcare messages defined in one standard format into another.

Contribution

Key contributions of the study will be as follows:

- Gather information from literature and users about the health information systems deployed in a selected number of African countries with emphasis on
 - Standards used for interfacing, diagnosis, procedures & pharmaceuticals e.g. HL7, ICD-10, DICOM 3, etc
 - Standards used for Electronic Health Records e.g. HL7 CDA, DICOM SR, IHE XDS, openEHR
 - Whether they interoperate with any other systems deployed like Health Information Systems, Medical devices like ECG machines , X-Ray machines etc, and any Billing & Pharmacies deployed, and protocols they use for the intereactions
 - Technical Architectures used
 - Any web services technologies used
 - Operating systems the applications run on
 - The development languages used to develop
- Produce a description of Service Interfaces for use in Health care systems in Africa
- Produce an open standard SOA based architecture that represents e-Health software functionality as discoverable services in the health care industry.
- Produce an API for providing security, privacy and authentication in accessing medical information across different systems.

Systems and Literature Review done so far

There are two parts to the review done or to be done in future for this work. First review involves looking at systems already in place so that we can apply the bottom up approach and come up with a migration path to the ideal solution that will be derived. The second part is to look at a body of literature that has been produced on the aspects that affects this subject. The literature review will help with the top down approach to finding solutions of interoperability problems discussed thus far.

Systems review

The following are the systems that have been earmarked for study: DHIS, SYSTEC, RTC ART, OpenMRS and several applications installed by the Western Cape Provincial.

DHIS has the largest installation base in South Africa. It is only used for data collection and reporting. It does not have features that can be used in management of patients. The application and the source code have been made available for study.

OpenMRS is another open source application for managing HIV/AIDS patients and has wider use across Africa. Being open source, the code is available for study and analysis.

RTC ART is a web based application developed to manage HIV/AIDS patients in Mthatha Eastern Cape. The application is also available for study and review.

Other systems in South Africa that would be analysed in future include MEDICOM, OASIS, SYSTEC, MEDITEC, UNICARE, PAAB and PADS.

Systems used by the Western Cape Provincial government are being analysed at the moment. Certain parts of their application already use web services for cross platform interoperability.

Literature review

A number of publications have been looked at. These range from those that deal with problems in implementing health information systems in Africa to those that deal with health standards /interoperability issues. Some dealing with the use of service oriented architectures to deal with integration issues were also looked at.

On implementing Health Systems in Africa, Littlejohns et al described a failed attempt to implement a computerized information system among 42 hospitals in the Limpopo province of South Africa (Littlejohns et al, 2003). They provide a list of possible reasons for this failure and summarize the lessons learnt. The project experienced two failure attempts by two different vendors namely the international IBM and the South African ETHNIKS. The contract was first awarded to IBM at cost of R134 million. IBM managed to build the system and deploy computers, but the implementation and roll out failed. This was largely, among other reasons, due to the absence of adequate infrastructure in the rural province and failure to ensure the users of the system understand the reasons for implementing the new system. After IBM failure, the contract was awarded to ETHNIKS, a South African software company. ETHNIKS also failed to meet the users' expectation. One of the reasons for their failure was their attempt to get rid of the old system and introduce a new one rather than extend the existing system. This case illustrates the challenges of replacing old systems with new ones rather than building on what is on the ground.

Staying with difficulties in implementing systems in Africa, Braa and Muquinge presented a paper at the Bamako eHealth conference in January, 2007 in which they described and discussed the experiences from the collaboration with partners in their HISP/BEANISH network, the collaboration of African and European countries to promote ICT in eHealth. Braa et al start by stating that despite considerable effort made by governments and appropriate international agencies to address a number of healthcare issues in Africa using Health Information Systems (HIS), there are still difficulties on the ground when it comes to developing HIS systems. This is mainly due to organisational complexity, fragmented and uncoordinated organisational structures all maintaining their own HIS, unrealistic ambitions and more generally lack of human resources and sustainability. They further described the collaboration with the HISP in building an open source web based health information system called DHIS 2. The paper recognises the challenges of building an integrated system encompassing the various information needs and recommends building capacity and linking up with capacities found in universities.

On standards, Bourne and colleagues outline the development of a health information standards framework for South Africa. They first describe the reforms the medical sector was undergoing and explain how health care services are managed and the various committees established to deal with needs for both the public and private sectors. The initial emphasis in the public sector has been the development of data and coding standards. Both the private and public sector had agreed on the adoption of International classification of diseases, ICD-10, as a standard for diagnostic coding. Other standard codes include, the Current Dental

Terminology (CDT), DICOM 3 for telemedicine, and the UN EDIFACT for standard messaging. The possible adoption of the Health Standard Level 7 for the general aspect of messaging remains to be resolved at the time of writing (Bourne et al, 1998). Looking at recent government documents, it can be deduced that the government has settled for the support of HL7 in their implementation of an integrated system (SITA, 2006)

Another paper reviewed on standards is by Eichelberg and colleagues where they did an analysis of electronic healthcare standards currently under development meant to address interoperability issues by structuring and marking up the clinical content for the purpose of exchange (Eichelberg et al, 2005). They presented the most relevant Electronic Health Record standards namely CEN standard EN 13606 Electronic Healthcare Record Communication (CEN EHRcom), HL7 Clinical Document Architecture(HL7 CDA), Web Access to DICOM Persistent Objects (ISO WADO), DICOM Structured Reporting (DICOM SR), Integrating The HealthCare Enterprise(IHE), IHE Retrieve Information for Display (IHE RID) and Medical Markup Language (MML). The paper found these standards being developed to be incompatible in a number of ways and could not pick the winner that would be the ultimate standard, but concluded that the true interoperability among these standards will only be possible by providing semantic interoperability.

The theme of semantic interoperability is picked up by Dogac et al. In their paper presented at a conference in Spain, they discuss the lack of interoperability among different healthcare information systems as one of the obstacles to be overcome if interoperability issues are to be resolved. They also looked at other factors that affected interoperability such as interoperability of Electronic Healthcare Records (EHRs), patient identifiers, coding terms, clinical guidelines and healthcare business processes. (Dogac et al, 2006).

Another paper looked at was a critique of the HL7 Reference Implementation Model (RIM). HL7 is widely used world wide and most new systems on the African continent have plans to embrace it. Therefore it was thought appropriate to look at literature that documents some of the shortcoming of the HL7 RIM where the HL7 standard version 3 is based. Barry and Wener in their paper stated that despite the fact that HL7 has been around for 10 years and undergone considerable support in terms of resources, it still has problems. The problems they found with RIM include difficulty in implementation, problems of usability in specialist domains, problems of scope, poor documentation, high learning curve and premature marketing at a large scale when the technical problems RIM has have not yet been resolved. The authors believed that RIM could be saved if two related artifact are created namely the Reference Ontology Health Care Domain

and Model of Health Information. They believe these will create a coherent, clear and implementable HL7 model (Barry et al, 2006).

Ing-Yi and colleagues describe a Service-Oriented Agent Architecture used to provide a solution for health services management (Ing-Yi, 2005). The Architecture was implemented on the Open Services Gateway Initiative framework (OSGi). OSGi is an open standard programming interface industry plan for a standard way to connect devices the Internet infrastructure. Ing-Yi described how OSGi enabled healthcare services providers to bridge the gap between various devices' application environment. This paper was useful as it dealt with connecting devices to the network. The hospital environment is a place full of medical devices that need to be integrated into network infrastructure.

There is also an industry white paper with a commercial pitch that was reviewed. It was reviewed because it raises some practical aspect that anybody considering the use of an SOA ought to be aware of. Jonathan Purdy starts by stating the benefits that SAO bring to the enterprise. Developing a SOA that guarantees service performance, scalable throughput, high availability and reliability is both a critical imperative and a huge challenge for today's enterprise (Purdy J, 2006). One of the huge challenges that SOA presents is the nature of the traffic conversation state used. For example, the HTTP session state utilised by Web Services, is often short-lived, rapidly modified and repeatedly used. Moving from a traditional user centric application to an SOA environment means that in addition to users, machines are now accessing services at machine speed. This in turn increases the rate at which the services are accessed, causing the maximum sustained request rate to far exceed the original requirements. The result is that technologies that were capable of handling traditional user loads are now almost crushed by the increased load associated with an SOA environment. Jonathan Purdy proposes clustered caching and data grid infrastructure to ensure availability, reliability and scalable performance for SOA. If this is not taken into consideration, a SOA application could lead to a degraded performance.

Other literature reviewed included the reference model for SOA from the OASIS group, HL7 Service Oriented Architecture and HL7 V3 methodology from the HL7 SOA Special Interest Group (SOA SIG). These papers elaborate on the best practice methods of developing SAO based architectures.

The South African government white paper on the national strategic framework for Electronic Health record was also reviewed (SITA, 2006). The document details the problems and frustration of the government in dealing with a health information system that is fragmented. The paper further outlines the government commitment to creating a national health information system that integrates both

the private and public sector. The tender document issued in connection with this paper was also reviewed as it outlined the specific standards and requirements that the government wants to have in the integrated health system.

Taxonomy and Classification of Problems and Issues

Term	Descriptions
API	An application programming interface (API) is an interface that a computer system or program library provides in order to support requests for services to be made of it by a computer program.
Architecture	The structure or structures of the system, which comprise software components, the externally visible properties of those elements, and the relationships between them.
Computing Environment	The institution ICT assets including PCs, servers, switches, hubs and other IT devices
CORBA	The Common Object Request Broker Architecture (CORBA) is a standard defined by the Object Management Group (OMG) that enables software components written in multiple computer languages and running on multiple computers to interoperate.
DCOM	Distributed Component Object Model, a Microsoft proprietary technology for software components distributed across several networked computers to communicate with each other
DICOM	The Digital Imaging and Communications in Medicine (DICOM) standard was created by the National Electrical Manufacturers Association (NEMA) to aid the distribution and viewing of medical images, such as CT scans, MRIs, and ultrasound. (http://www.sph.sc.edu/comd/rorden/dicom.html)
ESB	Enterprise Service Bus - An ESB acts as a shared messaging layer for connecting applications and other services throughout an enterprise computing infrastructure. It supplements its core asynchronous messaging backbone with intelligent transformation and routing to ensure messages are passed reliably. Services participate in the ESB using either web services messaging standards or the Java Message System (JMS) (Gartner)
Hardware	Computers, PCs Network, Scanners
Health Institutions	Could refer to a place that house any of the following

	:Hospitals, Clinics, Medical Labs, Pharmacies
HL7	Health Level Seven is one of several American National Standards Institute (ANSI) -accredited Standards Developing Organizations (SDOs) operating in the healthcare arena. Most SDOs produce standards (sometimes called specifications or protocols) for a particular healthcare domain such as pharmacy, medical devices, imaging or insurance (claims processing) transactions. Health Level Seven's domain is clinical and administrative data.(www.hl7.org)
ICD-10	The ICD has become the international standard diagnostic classification for all general epidemiological and many health management purposes. These include the analysis of the general health situation of population groups and monitoring of the incidence and prevalence of diseases and other health problems in relation to other variables such as the characteristics and circumstances of the individuals affected. It is used to classify diseases and other health problems recorded on many types of health and vital records including death certificates and hospital records. In addition to enabling the storage and retrieval of diagnostic information for clinical and epidemiological purposes, these records also provide the basis for the compilation of national mortality and morbidity statistics by WHO Member States.(www.who.int-ICD-10 updates)
ICT	Information and Communications Technology
Middleware	Integration software. Middleware is the term coined to describe software that connects other software together. Middleware aims to connect stovepipes of automation, both within an enterprise and out to external systems (for example at customers and suppliers). Typically middleware has either been custom coded for individual projects or has come in the form of proprietary products or suites, most notably as enterprise application integration (EAI) software. The emergence of industry-agreed web services specifications is now enabling convergence on standards-based distributed middleware, which in theory should allow all systems to automatically connect together on demand.
Network Infrastructure	The infrastructure connecting the devices like PCs Server, X-ray machines etc in an institution.
OASIS	Organization for the Advancement of Structured Information Standards - A leading e-business and internet technologies

	standards body. OASIS is a global consortium of tech industry and corporate members, dedicated to developing and championing XML-based standards for electronic business. OASIS is responsible for several emerging web services standards, most notably WS-Security and UDDI, as well as Web Services for Remote Portals (WSRP) and Web Services for Interactive Applications (WSIA). It is also jointly responsible, with UN/CEFACT, for ebXML and related standards. OASIS has a policy that standards specifications should be royalty-free.
Patient Records	Patient Records refers to a medical record that includes information relating to the current and historical health, medical conditions and medical tests of a patient. In addition, it may contain data about medical referrals, medical treatments, medications and their application, demographic information and other non-clinical administrative information.
RMI	Remote Method Invocation used in Java for accessing remote objects
Services	The Mechanisms by which needs and capabilities are brought together. Players involved in services are the service consumer and producer.
SOA	A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations. (OSAIS)
SOAP	Simple Object Access Protocol - The standard for web services messages. Based on XML, SOAP defines an envelope format and various rules for describing its contents. Seen (with WSDL and UDDI) as one of the three foundation standards of web services, it is the preferred protocol for exchanging web services, but by no means the only one; proponents of REST say that it adds unnecessary complexity.(www.3w.org)
UDDI	Universal Description, Discovery and Integration protocol - A directory model for services. UDDI is a specification for maintaining standardized directories of information about services, recording their capabilities, location and requirements in a universally recognized format. Seen (with SOAP and WSDL) as one of the three foundation standards of

	web services. (www.3w.org)
WSDL	An acronym for Web Services Description Language is an XML based interface definition format for network services. This definition enables the invocation method to be independent of the technology of the service implementation. (www.3w.org)

Recommendation for Research Directions

The key goal will be to define a Service Oriented Architecture (SOA) for Health Information Systems in Africa that is based on web services. To come up with this, a number of things have to take place. First, the collection of data from literature on how SOA has been used globally will have to be done. Secondly, the collection of literature data on what major systems in use across the continent of Africa will also have to be collected. Not all systems deployed across the continent will be studied. Systems that will be studied will include those used in more than two countries. Also, the local systems used in South Africa and Western Cape province will be studied as they accord the study the chance to have a deep look at real systems in place. The methods to be used in this study will be both top-down and a bottom-up approach.

The top-down approach will follow a three step process. The first process will involve defining the scope of the services in a health environment context. Basically, this process will determine what the clinical services actually are. This will help provide information about the big picture. The second process will identify who the external actors that drive the services or with which the services interact with. Actors are those organizations, people and services which interact with the services found in the first process. They provide the services with their external drivers and priorities. The last process will involve identifying why one clinical service talks to another and why external actors interact with the service. With information from the above processes, the implementation of the above services using current health standards will be looked at (Eichelberg et al, 2005). Literature of how these services have been implemented globally will also be studied.

The bottom-up approach will involve collecting data from the literature about deployed systems and also information about the actual deployed system. From this information, the study aims at finding out if most systems are just recording keeping applications or they have processes they coordinate (Boris et al, 2003). The aspects of the systems that will be studied include the following:

- What operating systems the applications run on.

- What type of network infrastructure they use to exchange data with their peers (standalone client/Server or web).
- What programming language they are developed in and whether that language supports web services API.
- What health standards they use (e.g. HL7 etc)
- What other cross platform applications they interoperate with.

With information from both the top-down approach and the bottom-up approach, the study will aim to propose a service oriented architecture and a migration path for the already deployed system.

Conclusion

The realities of interoperability and reusability problems have started to become more prominent in Africa as more systems are developed and deployed. The idea of having one system in place to solve this problem is not practical. The Service Oriented Architecture approach, based on web services, gives a lot of promise. There is so much hype and optimism about SOA today and this is not totally misplaced. The ideas of SOA are not new. The key difference today that makes SOA generate the kind of coverage it is receiving is that the technologies and infrastructure to make SOA a reality is in place. Systems that are in use today do not need to be thrown away. What they need, in addition to other standards issues, is an upgrade in order to expose them as web services and make them part of a Service Oriented Architecture. The challenge will be to define what those services are, what standards to use and how to resolve various technical issues of interoperability.

Acknowledgments

This paper has been put together with the help Prof Mikko Korpela, who helped with the selection of the topic for research and Prof Vesper Owei who helped with the structuring of the content headings.

References

- Asuma Dogac, Tuncay Namli, Alper Okcan, Gokce Lalec, Yildiray Kabak and Marco Eichelberg (May 2006) "Key Issues of Technical Interoperability Solutions in eHealth" *eHealth 2006 High Level Conference and Exhibition, Malaga, Spain*
- Barry Smith and Werner Ceusters (2006), "HL7 RIM: An Incoherent Standard", *Medical Informatics Conference Europe, Maastricht, August*

- Boris Lublinsky and Dmitry Tyomkin (October 2003) "Disecting Service Oriented Architectures" *Business Integration Journal* p 53-55
- D. E Bourne, L. A. Hanmer, K.J Heavens, (1998) "Towards developing a national health Information standards framework for South Africa" *International Journal of Health Informatics* 48 29-31
- Dag Von Lubitz and Nilmini Wickramasinghe 2006, "Healthcare and technology: the doctrine of networkcentric healthcare" *International Journal of Electronic Healthcare*,vol 2 no 4 pages 322-344
- Government of South Africa, (2004) "Department of Health, Strategic Priority for the National Health System, 2004 -2009" *Government White Paper*
- Ing-Yi Chen Chao-Chi Huang, (2005) "A Service Oriented Agent Architecture to Support Telecardiology Services on Demand" *Journal of Medical and Biological Engineering* 25(2): 73-79
- Hamish SF Fraser,Paul Biondich ,Deshen Moodley,Sharon Choi,Burke W Mamlin,Peter Szolovits (2005), "Implementing electronic medical record systems in developing countries" *Informatics in Primary health Care* , 13 Pages 83-95
- Jon Braa, Humberto Muquinge (January 2007) "Building Collaborative Networks in Africa on Health Information Systems and open source software development-Experiences from the HISP/BEANISH network" *Bamako January, eHealth Conference*
- Jonathan Purdy (2006) "Data Grids Vs SOA" *Tangosol Inc, Data Grid Solutions White Paper*
- Koos Louw and Lyn Hanmer, (July 2002), "ICT Diffusion and Applications" By Philip Esselaar (Project Manager), Tina James, Jonathan Miller and Graham Sibthorpe *DEPARTMENT OF TRADE AND INDUSTRY POLICY SUPPORT PROGRAMME*
- Marco Eichelberg, Thomas Aden, Jorg Reismeier, Asuman Dogac, Gokce B LalecA (November 2005), "Survey and Analysis of Electronic Health care Record Standards" *ACM Computing Surveys*, Vol V No N, 20YY pages 1-47)
- Mark v/d Heever, (2006). *Western Cape Province Western Cape Department of Health The Directorate: Communications Primary Health Care Information System for Community Health Centres*, last accessed March, 2006 Dec, 2006 <http://www.capegateway.gov.za/eng/pubs/news/2006/mar/133550>
- OASIS Group , (2006), "Specification Committee Reference Model for Service Oriented Architecture 1.0" *OASIS Committee Specification*
- Peter Littlejohns, Jeremy C Wyatt, Linda Garvican (April 2003), "Evaluating computerized health Information Systems: Hard Lessons still to be learnt" *British Medical Journal* Vol 326

The SA State Information technology Agency (Pty) Ltd –SITA, (2006) “The National Strategic Framework For eHR Implementation in South Africa” (*Supplement to 2006 Bid Document for Electronic Health record in South Africa*)

The SA State Information technology Agency (Pty) Ltd –SITA, 2006, The Procurement of an Electronic Health Record (eHR.ZA) system (Issue date 16th June 2006 RFP NUMBER:

Adapting the DeLone and McLean IS Success Model – A PDA Impact Study in Norwegian Home Health Care

Kari Aasheim

MSc Agder University College, Norway

kari.asheim@hia.no

Abstract. This paper introduces an extended version of the DeLone and McLean IS Success model, incorporating an additional variable with context specific features related to PDA implementations in home health care. The main purpose of the paper is to map PDA impacts and its success determinants, and assess whether the extended model is feasible as tool for PDA success evaluation in Norwegian home health care. The model was tested through a quantitative study, and the findings show that impacts from PDA usage are overall positive. The key PDA success determinants in Norwegian home health care are Information Quality and Contextual features, which are positively correlated to User satisfaction, and User satisfaction which is vaguely positively correlated with Use, and highly positively correlated to Impacts. The findings justify an extension of the model, and the large variance explained in both User Satisfaction and Impacts indicates that it may be successfully used as an evaluation tool in this context.

Keywords. PDA, Home Health Care, Evaluation, IS Success, System Quality, Information Quality, Service Quality, Contextual features, User satisfaction, Use, Impacts.

Introduction

Lacking positive impacts from IT investments is a commonly known phenomenon in modern organizations (Lin, 2001; Brynjolfsson, 1993). There are many fallpits in the benefit realization process (Davern, 2000), and escaping impacts may be caused by a number of reasons, such as mal evaluation, time lags and poor management (Brynjolfsson, 1996). Furthermore, stakeholder disagreements (Serafeimidis, 2001; Seddon, 1999; Berg, 2001), user resistance (Prentice, 2002), lack of strategic IT alignment (Henderson, 1993; Luftman, 2000), limited and local IT use, and lack of workflow rearrangement, are known to impede positive impacts (Hammer, 1990 ; Venkatraman, 1994). The benefit realization process is thus a highly complicated activity that requires a broad focus.

Regardless of these challenges, companies invest large sums in IT solutions to gain benefits such as competitive advantage and reduced production cost (Brynjolfsson, 1996). Seddon (1999), estimates that worldwide IT spendings increase by a trillion dollar each year. Still, many IT systems fail to ever affect the productivity scales (Brynjolfsson, 1996; Brynjolfsson, 1998).

The public sector is not exempted from costly IT investments. Norwegian health care sector is for example continually renewing itself by searching for more effective ways of delivering health care services through IT investments (Bergstrøm, 2004; Hygen, 2005). This is a response to specific challenges like time constraints, high turnover, scarcity in financial resources (Engeseth, 2005), and a vast increase in the elderly population (Omsorgsdepartementet, 2006; Bergstrøm, 2004; Hygen, 2005).

Another example from this sector is the increasing use of PDA solutions to achieve mobile health information access within Norwegian municipal home health care units. The PDA solutions make it possible to access digital information wireless through small hand-held computers on a computer network. These solutions will be the main focus area in this paper.

The PDAs can be used to support a range of information dependent tasks in home health care. It gives possibilities of work list automation and mobile entries to patient health journals. It may also be used to access medical decision support tools, and as a communication device.

PDA usage in health care may have several potential benefits, such as time savings (Sausser, 2002; Caremobil, 2005; Turner, 2005), reduction in medical errors (Sausser, 2002), improved information access (Sausser, 2002; Caremobil, 2005), increased nursing quality (Tooey, 2004; Beyer, 2004), optimized work flow arrangements, improved decision support (Tooey, 2004), increased information quality (Langowski, 2005; Turner, 2005), removal of information duplication (Karlsen, 2005) and financial savings (Caremobil, 2005). However,

the empirical findings that this paper is based on, show that many of the home health care units have problems realizing all benefits of the PDA solutions.

PDA's are not yet very common in Norwegian home health care, and at the time of this study, only 6 out of 431 Norwegian municipalities had incorporated PDA solutions in their home health care services. However, according to PDA suppliers, a rapid implementation curve of such solutions is anticipated in the near future, validating a closer look at this phenomenon.

To determine whether ones IT solution is successful and gives the expected impacts, it is necessary to evaluate the IT investments carefully, as the benefits are not always tangible and obvious. This is a complex task, and one may need support from an evaluation model or method. DeLone and McLean (1992; 2003) have introduced two such evaluation models describing several factors that contribute to successful IT implementations.

The DeLone and McLean IS success models are commonly used within the IS evaluation tradition. However, to the authors knowledge, they have not been used to evaluate PDA solutions in Norwegian home health care. Furthermore, they seem to lack a variable embracing the contextual features that are held as key success factors by PDA project managers in this specific sector.

The motivation for this study is thus to map PDA impacts, its success determinants, and assess the feasibility of the extended DeLone and McLean IS success model, within the setting of PDA usage in Norwegian home health care.

Theoretical background

The first DeLone and McLean model was introduced in 1992, in order to make a common IS success model for the IS research field. The authors based the model on prior studies of IT systems evaluations, and found that they mainly recognized IS success factors within the areas of System Quality, Information Quality, User Satisfaction, Use, Individual and Organizational Impacts. A joint model, suitable for both predicting and evaluating IS success and Impacts, was thus presented (DeLone, 1992). Today, the model is labelled with an explanatory/predictive label in the Gregor IS theory taxonomy (Gregor, 2006), and it may be used as a generic IS success evaluation tool in many settings. The first model is presented in figure 1.

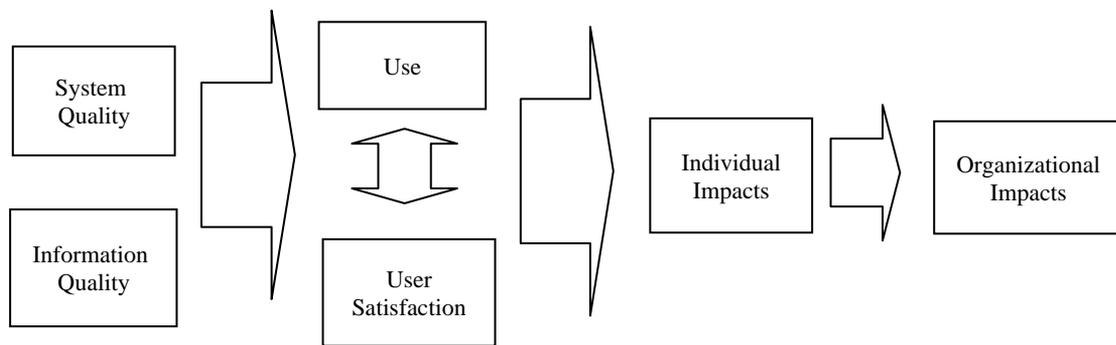


Figure 1: The Original DeLone and McLean IS success model

The model is a combined process and causal model, claiming that System Quality and Information Quality are determinants of User Satisfaction and Use, that User Satisfaction is a determinant of both Use and Individual Impacts, that Use is a determinant of User satisfaction and Individual Impacts, and that Individual Impacts is a determinant of Organizational Impacts (DeLone, 1992).

The model was subject to several rounds of critique. Seddon (1997) did for example advocate a richer view on stakeholder levels than that present in the model, although the model has a separation between individual and organizational impacts. He additionally criticised DeLone & McLean for incorporating the variable Use in a causal model, as he doubted whether Use actually causes effects.

The critique led to an updated model presented in 2003, where the variable Use was extended by Intention to use. Impact levels were additionally broadened to Net benefits, since one found that impacts in modern day's organizations to a large extent could exceed the organizational level. Finally, a new variable called Service Quality, that investigates user support quality, was incorporated. The updated model is pictured in figure 2.

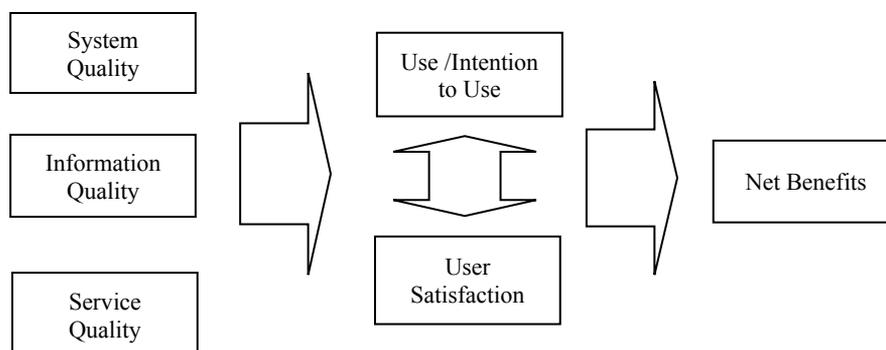


Figure 2: The updated DeLone and McLean IS success model

The models are aimed at predicting and explaining general IS success, but a PDA literature study, and qualitative interviews amongst managers in Norwegian home health care, indicated that the factors are just as relevant for evaluating PDA success in this sector. The models did however appear to have some shortcomings, as they failed to embrace certain context specific features that were found to be the four key success factors in PDA trials in Danish home health care. These key factors were quality of management, conscious work flow rearrangements, relevant user training and system quality (Caremobil, 2005). A small model extension therefore seemed reasonable.

Several papers from other sectors have recognized the importance of these particular key success factors when realizing IT related impacts. Regarding management, one for example find that both management-employee cooperation and management-employee support is important when mobile solutions are to be implemented (Luarn, 2005). Statskonsult (2006) even goes as far as claiming that benefit realization in public sector is not dependent on the superiority of the technology, but rather on how it is managed.

Similarly, work flow rearrangements are regarded as a key success factors for both general IT (Hammer, 1990) and PDA implementations (Strøm, 2003; Linstad, 2005, Hanseth, 2002).

Finally, regarding training, other PDA trials show that quality training is needed in order to use the system correctly and efficiently, and that failure in this area may impede PDA usage (Hsu & Smørdahl, 2002).

Based on these findings, it seems sensible to add a new variable in the model, to test whether these key success factors are of general importance amongst Norwegian health care PDA users.

Hypotheses and research model

The variable *System Quality* is recognized by technical features regarding the network and the IT equipment itself (DeLone, 1992; DeLone, 2003). Findings indicate that System Quality is positively related to User Satisfaction both when regarding PDA solutions and general information systems. (Hsu, 2002; Breivik, 2005; Engeseth, 2005; Davenport, 2003; Hanseth, 2002; Rai, 2002; Iivari, 2005) I assume that the same phenomenon will occur in Norwegian home health care, and claim that the variable belongs in a PDA evaluation model. Hence the following hypothesis is presented:

H1: There is a positive correlation between System Quality and User Satisfaction

The variable *Information Quality* is recognized by features regarding the actual information that is presented by the information system (DeLone, 1992; DeLone, 2003). Findings indicate that Information Quality is positively related to User Satisfaction both when regarding PDA solutions and general information

systems (Ellingsen, 2002; DeLone, 1992; DeLone, 2003; Almutairi, 2005; Iivari, 2005; Rai, 2002). I therefore assume that the same phenomenon will occur in Norwegian home health care, and claim that the variable belongs in a PDA evaluation model. Hence the following hypothesis is presented:

H2: There is a positive correlation between Information Quality and User Satisfaction

The variable *Service Quality* is recognized by features regarding internal user support services (DeLone, 1992; DeLone, 2003). Findings indicate that there is a positive correlation between Service Quality and User Satisfaction both when regarding PDA solutions and general information systems (DeLone, 1992; DeLone, 2003; Luarn, 2005; Hsu, 2002; Hussein, 2005; Kim, 2005). I therefore assume that the same phenomenon will occur in Norwegian home health care, and claim that the variable belongs in a PDA evaluation model. Hence the following hypothesis is presented:

H3: There is a positive correlation between service Quality and User Satisfaction

The variable *Contextual features* is not mentioned in the original DeLone and McLean's IS success models, and thus represents an extension. It is, as mentioned earlier, recognized by management support, employer/employee cooperation in the implementation project, user training and careful work flow rearrangements (Caremobil, 2005). Several papers stress the importance of these features for achieving successful IS implementations and IT usage (Hammer, 1990; Venkatraman, 1994; Statskonsult, 2006; Jacobsen, 2004; Hanseth, 2002; Strøm, 2003). I therefore assume that there will be a positive correlation between Contextual features and User satisfaction in Norwegian home health care, and claim that the variable belongs in a PDA evaluation model. Hence the following hypothesis is presented:

H4: There is a positive correlation between Contextual features and User Satisfaction

The variable *User satisfaction* is recognized by overall satisfaction with the PDA solution (DeLone, 1992). Findings indicate that there is a positive correlation between User Satisfaction and Use (Rai, 2002; Iivari, 2005). I therefore assume that the same phenomenon will occur in Norwegian home health care, and claim that the variable belongs in a PDA evaluation model. Findings additionally suggest that User satisfaction is positively correlated to Impacts (DeLone, 1992; DeLone, 2003; Iivari, 2005). I therefore assume that the same phenomenon will occur in the Norwegian home health care. Hence the following hypotheses are presented:

H5: There is a positive correlation between User Satisfaction and Use

H6: There is a positive correlation between User Satisfaction and Impacts

The variable *Impacts* is important to map, as one would hope to find evidence of IS success here. Thus the category naturally belongs in a PDA evaluation model. As discussed earlier, impacts may come at various stakeholder

levels, take several forms and differ in stakeholder groups (Seddon, 1999). This paper mainly maps impacts at an individual level amongst the PDA users.

The variable *Use* is debated for its relevance as an IS success measure, as organizational IT use may be enforceable. It can therefore be difficult to say whether the use is a result of user satisfaction or the actual mandation in mandatory settings. This may make Use unsuitable as an expression for both user satisfaction and IS success in mandatory settings (DeLone, 2003).

As PDA usage in the units examined in this study, to a large extent was mandatory, it made sense to measure PDA success in Impacts, and not Use. The Use variable is therefore present to give a general overview of what PDA functions that are used, and to what extent they are used.

Use, like it is measured in this paper, is narrowed down to a frequency measurement. Recently, researchers have been critiqued for treating use in this way, when operationalizing technology acceptance models, because it gives to little information about the concept (Schwarz & Chin, 2007). Several additional use measures such as high / low structural usage and cognition has been suggested (Burton-Jones & Straub, 2006), indicating that one might gain much by approaching the use concept in multiple ways. However, it is, no matter the operationalization, clear that a variable capturing Use belongs in a PDA evaluation model as Use is a prerequisite for any effects in this context. It is thus not always necessary that there is a positive correlation between increased use and impacts, as the nature of home health care work is practical, and spending to much time on the PDA would delay other highly important tasks. The causality between Use frequency and Impacts is thus not examined in this study.

The adapted PDA success model is pictured in figure 3.

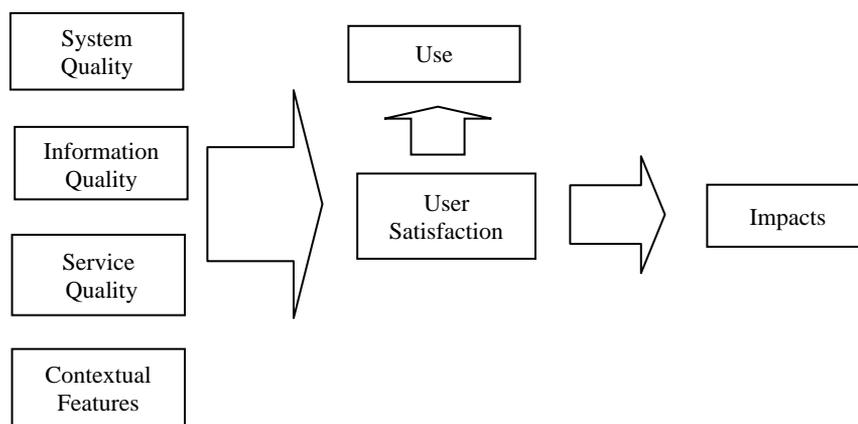


Figure 3: Adapted PDA success model

Research Method

The extended model was tested amongst PDA users in Norwegian home health care. The model feasibility was first assessed by studying PDA literature, by discussing PDA usage in depth with home health care employees during a 1 day stay at a home health care unit, and through 5 telephone interviews with PDA project leaders.

The extended model appeared appropriate and covered a majority of the issues related to PDA solutions, and thus a shift towards a quantitative approach was taken, to test whether the findings were generalizable.

All variables, besides Contextual features and Impacts, were operationalized using pre-tested measurements. The operationalizations may be found in the appendix.

The data was collected within a time frame of two months in 5 out of the 6 municipalities using PDAs. The respondents were reached via a contact person in each home health care unit. Due to practical issues the contact person was left in charge of gathering possible respondents. To ensure sufficient validity, the contact persons were instructed to ask as many PDA users as possible to participate, if possible all PDA users at their unit. The contact persons were additionally asked to keep track of the total number of respondents that had been asked to participate in the survey. They were clearly informed on how to maintain anonymity and avoid asking “clusters” of respondents within certain sub groups of PDA users, such as for example overall positive users, as this could influence the data material in a negative way.

The questionnaire was tested several times by co-students and finally by 3 nurses in a home health care unit before distribution. It was offered in both paper copies and online versions. It mainly consisted of 5 point Likert scales (Likert, 1932) ranging from overall negative to overall positive. The total number of questionnaires handed out was 191, and the total amount of usable questionnaires returned was 98. The overall percentage of answers was 51 %, ranging from 16 % as the lowest, to 90 % as the highest rate. Table 1 gives an overview of the participation rate in all municipalities. The surprisingly high participation rate in some municipalities may be explained by the small units in some of the home health care sectors, allowing for a tighter follow up on the process of both disassembling and recollecting questionnaires.

Municipality	Number of questionnaires handed out	Number of questionnaires returned	Percentage
1	30	5	16 %
2	31	28	90 %
3	51	15	29 %
4	41	30	73 %
5	38	20	53 %
<i>Sum: 5</i>	<i>Sum: 191</i>	<i>Sum: 98</i>	<i>Sum: 51 %</i>

Table 1: Participation rate

Results and data validation

To ensure data quality, data skewness and kurtosis were assessed, and three outliers were removed due to exceeding values, as recommended by Sjørebø (2003). Divergent factor validity was also tested, showing values within the given ranges, of +/- 0.3 for all factors, as recommended by Sjørebø (2003). Finally, internal factor validities were measured through Chronbach Alpha testing, showing scores within range of the recommended values of 0, 7-1 (Hair, 2005). The Alpha scores are pictured in table 2.

Variable	Alpha	Number of Items
System Quality	,907	12
Information Quality	,948	14
Service Quality	,958	13
Contextual Features	,950	13
Use	,724	8
User Satisfaction	,932	8
Impacts	,955	36

Table 2: Chronbach alpha value

Analysis

Descriptive statistics show that the median of PDA training duration was 1 hour, and that the most frequently used PDA functions were telephoning, receiving work lists, reading medical procedures, register patient information after visits, and reading patient information.

Negative impacts from the PDA solutions seem to be rare, and several positive impacts are mentioned. Many of the respondents feel that their work has become easier, that they have an increased overview of patient information, that time savings can be used to increase patient quality, and that PDAs have simplified documentation of care and increased the quality of documentation. The

majority of time savings are related to patient visit preparations and finding patient information

There are few reports of reductions in mal treatment and medical errors. Neither do the respondents save much time on driving, or ordering medical material and medicines after the PDA implementations. The latter may partly be explained by the fact that one only order medical materials for the patients once in a while and that only a few chosen persons at a time are responsible for ordering medicines.

Testing hypotheses

H1: There is a positive correlation between System Quality and User Satisfaction. The test of the relationship between System Quality and User Satisfaction reveals no significant correlation. The Beta value is, 04 at a significance level of, 686. The findings thereby offer no support for hypothesis 1.

H2: There is a positive correlation between Information Quality and User Satisfaction. The test of the relationship between Information Quality and User Satisfaction reveals a significant correlation. The Beta value is, 40 at a significance level of, 001. The findings thereby offer support for hypothesis 2.

H3: There is a positive correlation between service Quality and User Satisfaction. The test of the relationship between Service Quality and User Satisfaction reveals no significant correlation. The Beta value is, 04 at a significance level of, 718. The findings thereby offer no support for hypothesis 3.

H4: There is a positive correlation between Contextual features and User Satisfaction. The test of the relationship between Contextual features and User Satisfaction reveals a significant correlation. The Beta value is, 41 at a significance level of, 002. The findings thereby offer support for hypothesis 4. All findings are pictured in table 3.

Independent Variables	User Satisfaction	Significance level
System Quality	β ,040	,686
Information Quality	β , 403	,001
Service Quality	β , 047	,718
Contextual Features	β , 411	,002
ANOVA	R2 ,605	,000

Table 3: Hypothesis 1-4

The first four independent variables manage to explain a total of 60, 5 % variance in User Satisfaction, indicating that at least Information Quality and Contextual features are highly important for PDA user's satisfaction in the Norwegian home health care. The model fit is pictured in table 3.

H5: There is a positive correlation between Contextual features and User Satisfaction. The test of the relationship between User satisfaction and Use reveals a small correlation. The Beta value is, 21 at a significance level of, 067. However, User satisfaction only manages to explain a total of 3, 3 % variance in Use, offering a vague support for hypothesis 5. Findings are pictured in table 4.

Independent Variable	Use	Significance level
User Satisfaction	β , 214	,067
ANOVA	R2 ,033	,067

Table 4: Hypothesis 5

H6: There is a positive correlation between User Satisfaction and Impacts. The test of the relationship between User satisfaction and Impacts reveals a significant correlation. The Beta value is, 79 at a significance level of, 000. In addition, User satisfaction manages to explain a total of 62, 9 % variance in Impacts at a significance level of, 000. The findings thereby offer a strong support for hypothesis 6. Findings are pictured in table 5.

Independent Variable	Impacts	Significance level
User Satisfaction	β , 797	,000
ANOVA	R2 ,629	,000

Table 5: Hypothesis 6

The findings establish a positive correlation between Information Quality, Contextual features and User satisfaction. However, the two independent factors are comprised of several sub factors. A closer look at them show that Information Quality is comprised of information output format, information error rate and information value. Similarly, Contextual features is comprised of amount of training, quality of training, management role and work flow rearrangements, (WR). To find which exact sub factors that affect User satisfaction, the variables were decomposed and exposed to a new regression analysis. The decomposed variables are pictured in figure 4 and 5.

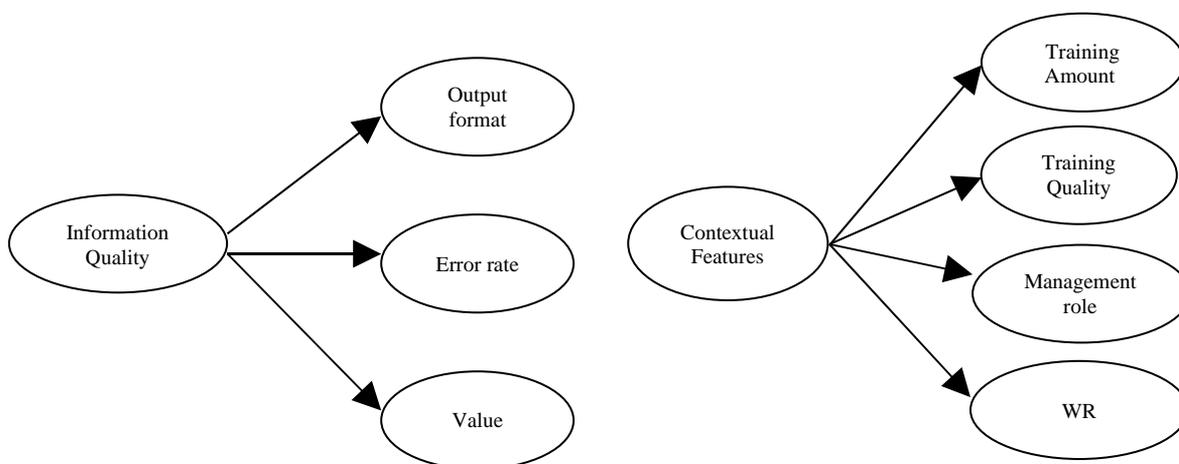


Figure 4: Decomposed Information Quality **Figure 5: Decomposed Contextual features**

The regression of the decomposed variables reveals that only two sub factors are significantly affecting User Satisfaction, namely Information Value and Work flow rearrangements. Information Value has a Beta value of, 40 at a ,019 significance level. Work flow rearrangements has a Beta value of ,49 at a ,000 significance level. Training quality borders at significance at a ,160 level, and may also possibly be of importance. Information output format, error rate, training duration and management role are all insignificant. All together the variables manage to explain a total of 65, 4 % variance in User Satisfaction at a significance level of ,000. The findings are pictured in table 6.

Independent Variable	User Satisfaction	Significance level
Output format	β ,-.094	,579
Error rate	β , 131	,294
Information value	β , 408	,019
Training duration	β ,-.020	,797
Training Quality	β , 153	,160
Management role	β , -115	,335
WR	β , 492	,000
ANOVA	R2 ,654	,000

Table 6: Regression of decomposed variables

Discussion

The descriptive statistics show that only a few PDA features are used regularly, and that potential effects mentioned in the literature fail to occur. This may be related to the fact that many effects, like medical error reduction, is dependent on using special features or programs in the PDA. If one does not give training in

these task specific features, and make a new workflow arrangements, there may be no effects.

Furthermore, it seems questionable whether the potential effects in the literature such as financial savings, are realistic. In fact, many of the Norwegian municipalities experienced increased costs related to the PDA solutions. This may indicate that the solution should be judged by its quality enhancing potentials, rather than by its financial potentials.

Regarding the general fit of the model, it manages to explain a large amount of variance in both User Satisfaction and Impacts, and some variation in Use. It furthermore confirms parts of the original DeLone and McLean IS success models and many of the previous PDA findings that inspired the hypotheses. The model thus seem to have a good explanatory power in Norwegian home health care.

Confirming the original DeLone and McLean models (DeLone, 1992; DeLone, 2003) the findings show that Information Quality is an important predictor of PDA success. This is not a surprise regarding that nursing is a highly information dependent occupation, where one needs accurate information to give accurate care.

The high variance in User satisfaction caused by Contextual features, support the theory suggesting that the experiences from Danish PDA trials are of importance in Norway as well, at least when regarding reorganizing work flows. This aspect of the variable should thus be incorporated in a PDA evaluation model on a permanent basis.

Surprisingly neither System Quality or Service Quality are predictors of PDA success in Norwegian home health care, even though System Quality was mentioned as a highly important success factor by PDA project leaders during the initial qualitative interviews. A possible explanation for the lack of correlation between the variables, may be that both Service Quality and System Quality were at what was conceived a sufficient level, and that it therefore drew less attention than it would do for instance in a start up phase, or if the solution was troubled with ongoing technical problems.

The low variance in Use caused by User Satisfaction may be explained by the nature of home health care, which to a large extent is practical. PDAs can only be used to support a limited portion of the daily tasks, namely those that are information dependent. However, one can be very satisfied the few times one uses a function, and a small use frequency may even be appropriate for tasks such as medicine ordering, that is only conducted once in a while.

Finally the findings confirm that User satisfaction is a very strong predictor of Impacts. This indicates that one should work with determinants of user satisfaction in order to enhance effects of PDA solutions in Norwegian home health care.

Limitations

There are several limitations related to this study. Due to geographical issues and a low rate of e-mail usage in the respondent population, the author was not able to choose respondents. The respondent selection process, which was conducted by a contact person in each home health care sector, can therefore not be given a full guarantee regarding validity. Furthermore, operationalization of the model could have been made more thorough regarding both Contextual features and Use. Some of the used items also fail to be specific enough, and should be detailed at a lower level in future studies. Finally, the model has only been validated through one data collection, and further testing in the same respondent group, at a later point in time, would increase validity of the extended model.

Conclusion

This study has assessed impacts, and the feasibility of an adapted DeLone and McLean IS Success model regarding PDA solutions in Norwegian home health care, and the model seems feasible in this context.

Like findings in Denmark (Caremobil, 2005), the PDA investments appear to be positive for Norwegian home health care, in spite of the increased costs. However, it is possible that cost savings will come when one starts using PDAs for digital information exchange between the home health care units and doctor, pharmacy etc, in addition to the local work flow optimization we see today. One may also see cost savings at other stakeholder levels, like in municipal budgets.

Future research should map and evaluate coming PDA implementations in home health care, to further assess the validity of the model. Efforts should be made to clearly define, develop and validate a more decomposed measurement tool for the variable Use and its relationship with PDA Impacts. One should also try to assess whether the importance of System Quality and Service quality diminishes over time, if the system is relatively well functioning.

Finally, a special emphasis should be placed on how to decompose and map the specific workflow rearrangements that are successful in this particular setting, and possibly map them to impacts, to enhance understanding of this highly complex variable.

Acknowledgements

Thanks to: Master thesis supervisor Tom Roar Eikebrokk for his valuable support. PDA users and contact persons in all municipalities. Snorre Johansen at TietoEnator and Arild Sæle at ACOS for information regarding the PDA solutions.

References

- Almutairi, H., & Subramanian, G. H. (2005). "An Empirical Application of the DeLone and McLean Model in the Kuwaiti Private sector", *Journal of Computer Information Systems*, Spring, 113-122.
- Bailey, J. & Pearson, S. W. (1983). "Development of a tool for measuring and analyzing computer user satisfaction", *Management science*, vol. 29, nr. 5, 530-545.
- Berg, M. (2001). "Implementing information systems in health care organizations: Myths and challenges", *International Journal of Medical Informatics*, vol. 64, 143-156.
- Bergstrøm, R., & Heimly, V. (2004). "Information Technology Strategies for Health and Social Care in Norway", *International Journal of Circumpolar Health*, vol. 63, 336-348.
- Beyer, M., Kuhn, K. A., Meiler, C., Jablonski, S., & Lenz, R. (2004). "Towards a flexible, process-oriented IT architecture for an integrated healthcare network.", *Proceedings of the 2004 ACM Symposium on Applied Computing*, New York.
- Breivik, E. (2005). "Økonomisk evaluering av innføring av EPJ og mobile enheter i Vindafjord kommune", NST- Nasjonalt Senter for Telemedisin, Tromsø.
- Brynjolfsson, E. (1993). "The productivity Paradox of Information Technology", *Communications of the ACM*, vol. 36, no. 12, 94-109.
- Brynjolfsson, E., & Hitt, L. (1996). "Paradox Lost? Firm-level Evidence on the Returns to Information Systems Spending", *Management Science*, vol. 42, no. 4, 541-141.
- Brynjolfsson, E., & Hitt, L. (1996). "Beyond the Productivity Paradox", *Communications of the ACM*, vol. 41, no. 98, 49-55.
- Burton-Jones, A. & Straub Jr., D. W. (2006). "Reconceptualizing System Usage: An Approach and Empirical Test", *Information Systems Research*, vol. 17, no. 3, 228-246.
- Caremobil. (2005). "Effektvurdering af anvendelse af mobile IT-løsninger på ældreområdet", Socialministeriet.
- Davenport, C. (2003). "Analysis of PDAs in Nursing: Benefits and Barriers", Retrieved 12. June, 2006, from http://www.rnpalm.com/Analysis_PDAs_Nursing.htm
- Davern, M. J., & Kauffman, R. J. (2000). "Discovering Potential and Realizing Value from Information Technology Investments", *Journal of Management Information Systems*, vol. 16, no. 4, 121-143.
- Davis, F. D. (1989). "Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology" *MIS Quarterly*, vol.13, no. 3, 319-340.
- Dellinger, T. M. (2005). "A little knowledge goes a long way: Understanding PDAs", *Debt Cubed*, vol. 20, no. 2, 32-33.
- DeLone, W. H., & McLean, E. R. (1992). "Information Systems Success: The Quest for the Dependent Variable", *Information Systems Research*, vol. 3, no. 1, 60-95.
- DeLone, W. H., & McLean, E. R. (2003). "The DeLone and McLean Model of Information System Success: A Ten-Year Update", *Journal of Management Information Systems*, vol. 19, no. 4, 9-30.
- Ellingsen, K. B., & Smørdal, O. (2002). "PDA as an information infrastructure", Intermedia Report 5, UIO, Oslo.
- Engeseth, K. (2005). "Sluttrapport Mobil Omsorg. Innføring av elektronisk journal og mobile enheter i Vindafjord kommune - en evaluering", NST-report no: 07-2005, Tromsø.

- Gillingham, W., Holt, A., & Gillies, J. (2002). "Hand-held computers in healthcare: what software programs are available?", *The New Zealand Medical Journal*, vol. 115, no. 1162, 1-21.
- Gregor, S. (2006). "The nature of theory in information systems", *MIS Quarterly*, vol. 30, no. 3, 611-642.
- Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2005). "*Multivariate Data Analysis* (6 ed.)", Pearson, Prentice Hall, New Jersey.
- Hammer, M. (1990). "Reengineering Work: Don't Automate, Obliterate", *Harvard Business Review*, vol. 68, no. 4, 104-112.
- Hanseth, O. (2002). "*Bootstrapping mobile computing in medicine*", Intermedia Report 5, UIO, Oslo.
- Henderson, J. C. & Venkatraman, N. (1993). "Strategic Alignment: Leveraging Information Technology for Transforming Organizations", *IBM Systems Journal*, vol. 32, no. 1, 4-16.
- Hsu, D., & Smørðal, O. (2002). "*Barriers and triggers for use of PDA in medical practice*", Intermedia report 5, UIO, Oslo.
- Hussein, R., Selamat, H., & Karim, A. N. S. (2005). "*The Impact of Technological Factors on Information Systems Success In The electronic Government Context*", The Second International Conference on Innovations in Information Technology.
- Hygen, J. (2005). "*Health Informatics and Telemedicine in Norway*", *NST - 10th anniversary bulletin*, 1-5.
- Jacobsen, D. I. (2004). "*Organisasjonsendringer og endringsledelse*", Fagbokforlaget, Bergen.
- Karlsen, E. B. (2005). "*Mobile terminaler i den kommunale hjemmetjenesten*", Unpublished Master thesis, NTNU, Trondheim.
- Kettinger, W. J. & Lee, C. L. (2005). "Alternative Scales for IS SERVQUAL", *MIS Quarterly*, vol. 29, no. 4, 1-17.
- Kim, Y. J., Eom, M. T. I., & Ahn, J. H. (2005). "Measuring IS Service Quality in the Context of the Service Quality-User Satisfaction Relationship", *Journal of Information Technology Theory and Application*, vol. 7, no. 2, 53-70.
- Langowski, C. (2005). "The Times They Are A Changing: Effects of Online Nursing Documentation Systems", *Q Manage Health Care*, vol. 14, no. 2, 121-125.
- Likert, R. (1932). "*A Technique For The Measurement of Attitudes*", Doctoral Thesis, Columbia University.
- Lin, C., & Pervan, G. P. (2001). "A review of IS/IT Investments Evaluation and Benefits, Management Issues, Problems and Processes", In W. V. Grenbergen (Ed.), *Information technology Evaluation Methods and Management*, pp. 2-24, Idea Group Publishing, London.
- Linstad, L., Rotvold, G. H., Normann, T., Eidissen, O., & Poppe, W. (2005). "*Prosjektrapport Helse-IT - nye markeder, utvikling av telemedisinske tjenester*", NST-rapport: 01-2005, Tromsø.
- Iivari, J. (2005). "An empirical test of the DeLone-McLean model of information system success", *Communications of the ACM*, vol. 36, no. 2, 8-27.
- Luarn, P., Lin, T. M. Y., & Lo, P. K. Y. (2005). "Non-Enforceable implementation of enterprise mobilization - an exploratory study of the critical success factors", *Industrial Management & Data Systems*, vol. 105, no. 6, 786-814.
- Luftman, J. N. (2000). "Assessing Business-IT Alignment Maturity", *Communications of AIS*, vol. 4, no. 14.
- Meister, D. B. & Compeau, D. R. (2002). "*Infusion of Innovation Adoption: An individual Perspective*", ASAC, Winnipeg, Manitoba, 23-33.

- Omsorgsdepartement, D. K. H. O. (2006). "Mestring, muligheter og mening. Framtidas omsorgsutfordringer", Stortingsmelding nr. 25, Det Kongelige Helse og Omsorgsdepartement, Oslo.
- Pitt, L. F., Watson, R. T. & Kavan, C. B. (1995). "Service Quality: A Measure of Information Systems Effectiveness", *MIS Quarterly*, vol. 19, no. 2, 173-188.
- Prentice, S., Phenister, T., Gemini, C., & Young, E. (2002). "Technology in Health Care: A summary of the NZIHM annual conference 2002 "Technology - Adding Value to Health"", *Health care and informatics review online*, vol. 6, no. 4.
- Rai, A., Lang, S. S., & Welker, R. B. (2002). "Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis", *Information Systems Research*, vol. 13, no.1, 50-69.
- Sausser, G. D. (2002). "Use of PDAs in Health Care Poses Risks and Rewards", *Healthcare Financial Management*, vol. 56, no. 5, 86-8.
- Seddon, P. B. (1997). "A Respecification and Extension of the DeLone and McLean Model of IS Success", *Information Systems Research*, vol. 8, no. 3, 240-253.
- Seddon, P. B., Staples, S., & Patnayakuni, R. (1999). "Dimensions of Information Systems Success", *Communications of the Association for Information Systems*, vol. 2, no. 3, 1-39.
- Serafeimidis, V. (2001). "A Review of Research Issues in Evaluation of Information Systems" In W. V. Grenbergen (Ed.) *Information technology Evaluation Methods and Management*, pp. 58-77, Idea Group Publishing, London.
- Sosial og Helsedirektoratet (2004). "S@mspill 2007. Elektronisk samarbeid i helse- og sosialsektoren", Sosial og Helsedirektoratet, Oslo.
- Statskonsult (2006). "Gevinstrealisering knyttet til omstilling og effektivisering ved utnyttelse av IKT", Retrieved 21.09.06, 2006, from <http://www.statskonsult.no/prosjekt/gevinstrealisering/index.htm>
- Strøm, H., Fløtterød, Ø., Dolva, E., Dehli, W. P., Gaard, M., Berg, Å. (2003). "IT på Japanske sykehus - en kilde til inspirasjon og læring for norsk helsevesen?", KITH-Kompetansesenteret for IT i Helsesektoren.
- Schwarz, A. & Chin, W. (2007). "Looking Forward: Toward an Understanding of the Nature and Definition of IT Acceptance", *Journal of the Association for Information Systems*, vol. 8, no. 4, 232-243.
- Sørebo, A. M. (2003). "En innføring i kvantitativ dataanalyse med SPSS-11.0", Høgskolen i Buskerud, Hønefoss.
- Tooley, M. J., & Mayo, A. (2004). "Handheld Technologies in a Clinical Setting, State of the Technology and Resources", *AACN Clinical Issues*, vol. 14, no. 3, 342-349.
- Turner, P., Milne, G., Kubitscheck, M., Penman, I., & Turner, S. (2005). "Implementing a wireless network of PDAs in a hospital setting", *Personal and Ubiquitous Computing*, vol. 9, no. 4, 209-217.
- Turner, P., Milne, G., Turner, S., Kubitscheck, M., & Penman, I. (2004). "Towards the wireless ward: Evaluating a Trial of Networked PDAs in the National Health Service", *Mobile and Ubiquitous Info*, 202-214.
- Venkatraman, N. (1994). "IT-Enabled Business Transformation: From Automation Business Scope Redefinition", *Sloan Management Review*, vol. 35, no. 2, 73-87.

Appendix

<p>USE Meister & Compeau (2002) Caremobil (2005)</p> <p>5 Point Likert scale ranging from never, yearly, monthly, weekly, to daily How often do you use the PDA to...? Receive work list Read patient information Read medical procedures Update medical procedures Register patient information after visit Read medicine catalogue Read medical support literature Read general online medical literature Surf the Internet Order medical material for patient Update medical list Order medicines Receive alarms Write driving list Study colleagues work progress Telephone Send E-mails Send SMS Navigate after GPS</p> <p>INFORMATION QUALITY Bailey & Pearson (1983) 5 Point Likert scale ranging from completely disagree to completely agree To what extent would you agree in the following claims regarding the patient information in the PDA? It is updated It is sufficient It has few errors It is easily understandable It is found in a logical place It is easy to find It is easy to retrieve It is relevant It is useful It is concise It is accessible when I need it It enables me to make the right decisions It fits to my work tasks I am dependent on it</p> <p>CONTEXTUAL FEATURES Caremobil (2005) 5 Point Likert scale ranging from completely disagree to completely agree To what extent do you agree with the following claims regarding the PDA training? It was sufficient It was good It was exiting It explained most of the PDA functionalities It was relevant for my work situation I could not have used the PDA effectively without it</p> <p>To what extent do you agree with the following claims? Management where present with guidance and information throughout the implementation process</p>	<p>SYSTEM QUALITY Almutairi & Subramanian (2005) Caremobil (2005). DeLone & McLean (1992) 5 Point Likert scale ranging from very unsatisfied to very satisfied How satisfied are you with the PDA regarding...? The timeliness of the information The different functions of the PDA The information sending and retrieval to patient journal On logging Of logging Information accessibility Network coverage PDA Weight PDA size Battery lifetime Keyboard functionality Screen size Screen solution</p> <p>SERVICE QUALITY Kettinger & Lee (2005) How satisfied are you with the user support when regarding...? 5 Point Likert scale ranging from very unsatisfied to very satisfied Service offered Problem solving speed Timeliness Keeping the system up and going Pre warnings when maintenance is due Personnel friendliness and service attitude Opening hours The ability to answer questions The ability to explain matters understandably The amount of work put in to give you a good system Understanding your needs Brochures and other information material offered</p> <p>USER SATISFACTION Inspired by Davis (1989) 5 Point Likert scale ranging from disagree to completely agree To what extent do you agree with the following claims? I need the information in the PDA to complete my work The PDA is very useful The PDA enables me to make better decisions I use the PDA for other tasks than required The PDA solution is easy to learn The PDA solution is well adapted to my work The PDA should become a standard work tool in home health care All in all I am very satisfied with the PDA solution</p> <p>IMPACTS I All Impact items are operationalized after inspiration from Caremobil (2005), PDA effect literature and interviews 5 Point Likert scale ranging from a very little extent to a very great extent To what extent has PDA usage given time savings in the following areas? Oral report Written reports Finding patient information Work list production</p>
---	---

<p>Management managed to support anxious employees in the PDA transition The PDA transition was a collaborative project between management and employees The work processes has been greatly changed after the PDA transition The work processes has been changed for the better after the PDA transition Today's work routines are sufficient to fulfil the PDAs full potential All in all I think that the PDA transition has been handled well</p> <p>IMPACTS II 5 Point Likert scale ranging from a very little extent to a very great extent To what extent has PDA usage led to the following effects? Medical error reduction Mal treatment reduction Error reduction in patient journal Reduction of information duplicates Less loss of important messages Improved quality of patient care Time savings can be used to increase patient quality Work is less stressful Work is easier Work is more social The PDA has made you more independent</p> <p>IMPACTS III 5 Point Likert scale ranging from a very little extent to a very great extent To what extent has PDA usage led to the following effects? Less control of your work situation Increased negative surveillance Increased demands to work faster Less time for each patient Focus is moved away from patient The PDA is s barrier in patient contact</p>	<p>Ordering medical equipment Ordering medicines Reading patient journal Driving Giving patient care Patient visit preparations Patient visit complementary work</p> <p>IMPACTS IIII 5 Point Likert scale ranging from a very little extent to a very great extent To what extent has PDA usage led to the following effects? A better operated home health care Increased professional confidence Increased patient involvement in care Increased patient access to journal information Increased patient influence on journal entry Increased quality of care documentation Simplification of care documentation Increased overview of patient information Increased work flexibility</p> <p>GENERAL QUESTIONS What is your occupation? What municipality do you work in? How many patients do you visit on an average day? How may hours of PDA training did you get? What format did the training have? How long have you been using the PDA?</p>
--	--

Unveiling the Mysterious Needs of Users

Anna Ståhbröst
Social Informatics
Luleå University of Technology
anna.stahlbrost@ltu.se

Birgitta Bergvall-Kåreborn
Social Informatics
Luleå University of Technology
birgitta.bergvall-kareborn@ltu.se

Abstract. Based on identified trends and weaknesses within IS literature in relation to unveiling the needs of users this paper aims to contribute to the field by presenting a method for eliciting, structuring and understanding user needs. The method, FormIT, is illustrated through a case study focused on increasing citizens' involvement in municipality matters. To FormIT we added a framework based on psychological motivators to structure and understand the needs. The findings from the study can be divided into three clusters. The first focuses on the technical solution, and product and service criteria that motivate the citizens to interact with local and central authorities. The second cluster relates to the needs expressed by the citizens and/or interpreted by the authors. They give an indication of needs that citizens consider important and that need to be considered when developing e-services geared at e-participation and involvement between citizens and public authorities. Finally, the third cluster of findings relate to the method and framework used to elicit, cluster and understand user needs. The most important finding and conclusion here is that the main strength of the framework is the discussion and reflection it generates.

Keywords. Needs, User Involvement, IT-Innovation, Motivators, Development Projects, Living Lab, Interaction Design

Introduction

Within IS literature it is possible to discern a growing interest in users' everyday behavior and needs as the information systems discipline is widening its borders and becoming both ubiquitous and pervasive (Kaasinen 2003; Holtzblatt 2005; Ha, Jung, and Oh 2006; Bergvall-Kåreborn, Holst, and Ståhlbröst 2007; Ericson and Ståhlbröst 2005). It is also possible to discern an expansion in the scope of investigation related to both user groups and use contexts including, for example, old people (Tiitta 2003), young people (Kankainen, Tiitta, and Rantanen 2003), and, people with specific interests such as sports (Holtzblatt 2005) or motorcycling (Esbjörnsson, Juhlin, and Östergren 2004).

Despite this broadening of the field there are authors that raise their voices and argue that the mainstream of our research is still too narrow in its point of view (Kankainen and Oulasvirta 2003; Bell and Dourish 2007). Kankainen and Oulasvirta (2003) argue that academic research in mobile and ubiquitous computing has been mainly technology-driven and focused on traditional use contexts and user groups. Bell and Dourish (2007) argues that the vision of ubiquitous computing and its inherent infrastructure as stable, uniform and seamless is not merely a dream of a world not yet realized; it is a dream of a world that could never be realized. Instead, we need to accept ubiquitous computing as the heterogeneous phenomena that it currently represents and focus on understanding how social and cultural practices is manifested and managed.

Based on the trends and weaknesses given above this paper aims to contribute to the field by presenting a method for eliciting, structuring and understanding user needs. The method is illustrated through a case study focused on increasing citizens involvement in municipality matters. Our part in the project was to elicit citizens' needs related to communication with local authorities, particularly concerning suggestions and alarms. In this work we have used a methodology called FormIT (Bergvall-Kåreborn, Holst, and Ståhlbröst 2007) which is user-driven rather than technology driven and accepts the heterogeneous nature of user needs and contexts. To this methodology we have added a framework based on psychological motivators to structure and understand the needs.

This paper starts with a short description of the FormIT methodology and the Reiss' framework of psychological motivators. Thereafter a presentation of the case and our needs elicitation process is given. The paper ends with some final remarks and reflections.

FormIT

FormIT is inspired by three theoretical streams; Soft Systems Thinking, Needfinding and Appreciative Inquiry (Bergvall-Kåreborn, Holst, and Ståhlbröst 2007). From the first stream, Soft Systems Thinking (Checkland and Holwell, 1998; Checkland and Scholes, 1990), we borrow the assumptions that changes can only occur through changes in mental models. This implies that we need understand both our own as well as other stakeholders worldviews and be clear about our interpretations and the base on which they are made. Hence, we aspire

to interpret and understand situations through an iterative interactive process with stakeholders.

The second stream, Needfinding, has two different inspirational sources. The needfinding concept as such and its motivation are mainly borrowed from Patnaik and Becker (1999). The main motivators for a needfinding approach are that needs are long lasting and as such they provides opportunities for design and supply a roadmap for future designs. The needs elicitation process, on the other hand, is inspired by (Kankainen, Tiitta, and Rantanen 2003; Kankainen and Oulasvirta 2003; Tiitta 2003). These authors inspired us to focus on user needs throughout the development process, and to use these as a foundation for the requirement specification.

The third stream, Appreciative Inquiry (Cooperrider and Avital 2004; Cooperrider and Whitney 2005; Cooperrider, Whitney, and Stavros 2005; Norum 2001), has encouraged us to focus on opportunities related to the specific context and visions for how IT/IS can radically alter, improve, or support the lives of a potential user group.

The FormIT process can be seen as a spiral where the focus for the design becomes more and more specific while the focus for evaluation broadens and takes on a holistic view on the use of the system, see figure 1.

The process starts by a general planning of the development process detailing the purpose of the project and different roles, activities and time frames. After this the needfinding process begins followed by conceptual design and evaluation, which ends the first cycle and starts up the second, unless the evaluation indicate that the cycle needs to be re-iterated. In the second and third cycle the focus is on IT-design and realising the concept design and in the second cycle the evaluation centre on usability while it centres on user experience as a whole in the third cycle. The development process ends with generating a market plan for how to disseminate the developed product or service. By this a new type of process and project starts.

In this paper, we focus on the needfinding process within the first cycle. Here, we start by identifying opportunities, strengths and best practices by stimulating users to provide rich and appreciative narratives about past and present situations. Based on these narratives the users are then asked to shift focus from appreciating “what has been” and “what is” to envision the future and “what might be”. From the stories of best practice and the dreams and wishes of the users, needs are identified and categorized and later translated into requirements.

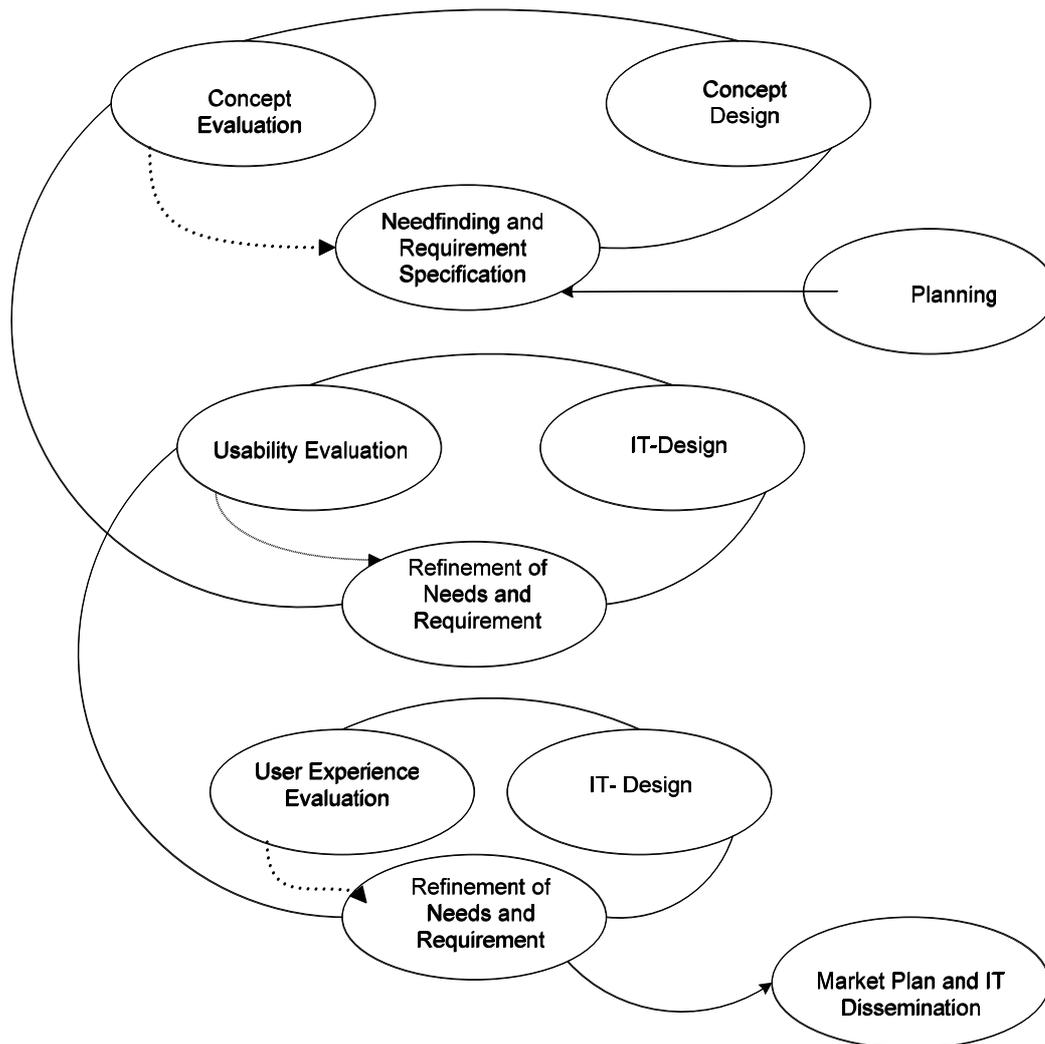


Figure 1. The FormIT Process for IS development

A Framework of Motivators

Within interaction design the process of finding needs has, however, not been established as a mature methodology and there are several reasons for this. First, the notion of user needs is inflated by the panoply of definitions and different usage seen in the design literature. In addition, the notion of needs is under debate within the psychology area. Second, to make the process of finding needs even more complex, there is almost no linkage between the use of the needfinding notion in interaction design and modern psychology. This means that there exists no common, shared typology within the design discipline about the kinds of needs that are relevant in interaction (Oulasvirta 2005). Mainly, cognitive psychology has had impact on modern user-centred design, whereas other branches of psychology have lagged behind. Today's psychology, with its emphasis on motivation, personality and emotion, has distinguished concepts to describe

intrinsic behaviour, such as goals, strivings, tasks, life narratives and so on (Oulasvirta 2005).

As a way to enrich the area of interaction design with psychology, we have chosen to use Reiss and Havercamps theory of human motivators as a tool to gain understanding of the nature of human behaviour and motivation. The aim with Reiss and Havercamps' studies has been to contribute to the area of knowing what people experience as meaningful behaviour, or what motivates them to act (Reiss 2004). Their studies ended up in a framework consisting of 16 basic desires, or motives (Reiss 2000). According to their theory, nearly all meaningful human behaviour is motivated by some compound variation of the 16 basic desires, or motives (Reiss 2004, 2001). The 16 motives are satisfied by meaningful behaviour and this is usually sought after in relationships, careers, families, sports and spirituality (Reiss 2001). Reiss have also found that motives are reasons why people, on a voluntary basis, are willing to do things; hence, knowing what motivates users is important in the processes of IT-development.

The idea of end motives started with Aristotle who divided motives into ends and means (Reiss 2000). End motives are things people enjoy for their own sake, whereas means are the methods for satisfying these end motives. Each of Reiss's 16 basic desires is an end motive. This means that the motive is a desire for its own sake and is based on the individual's purpose for why s/he acts in a certain way.

Motivators are experienced by everyone, but every individual vary with regard to the strength of each motive. Each basic desire motivates a basic goals, which are desired intrinsically – that is, for its own sake. As a matter of logic, we value what we desire for its own sake; therefore, the list of sixteen basic desires can be reworded as a list of sixteen fundamental values.

The experience of a basic desire being fulfilled produces an intrinsically valued feeling called “joys”, and the specific joy is different for each basic desire. Many activities that people do are aimed at satisfying some of these desires (Reiss 2004). We feel secure, for example, when we are in an environment with the degree of stability and order we like. We experience love when we spend time with our children and satisfy the desire for family. The satisfaction of each basic desire gives rise to a different joy, so we go through life trying to experience sixteen different types of intrinsically valued feelings. Soon after we satisfy a basic desire, the joy dissipates and the desire reasserts itself. Therefore, we seek activities that make possible repeated satisfactions of our basic desires (Reiss 2005, 2004). Because human motivation is fundamentally multifaceted, the sixteen desires cannot be reduced further into super categories such as pleasure versus pain or intrinsic versus extrinsic motivation. In addition, the sixteen basic desires are largely unrelated to each other (Reiss 2005).

Each basic desire, see table 1 below, is a continuum between two extremes, indicating the strong versus the weak variations of that desire. Individuals aim for different points along each continuum; that is, we seek to experience different intensities and frequencies of each of the sixteen desires (Reiss 2005). When it comes to peoples prioritising the sixteen basic desires, one size does not fit all. Although everyone is motivated by each basic desire, we are not motivated to the same extent (Reiss 2005).

Motivator	Motive	Intrinsic Feeling
Power	Desire to influence, leadership; related to mastery	Efficacy
Curiosity	Desire for knowledge	Wonder
Independence	Desire to be autonomous	Freedom
Status	Desire for social standing, desire for attention	Self-importance
Social contact	Desire for peer companionship, desire to play	Fun
Vengeance	Desire to get even, desire to compete, to win	Vindication
Honor	Desire to obey a traditional moral code	Loyalty
Idealism	Desire to improve society, including altruism and justice	Compassion
Physical exercise	Desire to exercise muscles	Vitality
Romance	Desire for sex, including courting	Lust
Family	Desire to raise own children	Love
Order	Desire to organize, desire for ritual	Stability
Eating	Desire to eat	Satiation
Acceptance	Desire for approval	Self-confidence
Tranquility	Desire to avoid anxiety, fear	Safe, relaxed
Saving	Desire to collect, value of frugality	Ownership

Table 1: Motivators (after Reiss 2004)

Salovaara (2004), claims that a need is the goal that a user wants to achieve by using a product; hence needs can be related to motivators and basic desires. Hence; needs can be related to motivators and basic desires and can be seen as expressions of the goals the users want to achieve.

In our study, we have used motivators as a tool for analysing the data gathered in the focus group interviews within the SMART project.

The SMART Project

The SMART project is one of many EU-projects aimed to increase citizen involvement in municipality matters through the use of new and innovative information and communication technology (ICT). SMART is a triple helix project, with University, SME and municipality partners from Sweden, and is financed by EU, objective 1, and Vinnova (Swedish Agency for Innovation Systems).

The objective of SMART is to explore the concept of "reaction media", allowing individuals to engage and take active in part in the development and improvement of their municipality. Today citizens seldom give suggestions and opinions for how they want the municipality to develop, nor do they alert or alarm identified risks or dangers in their environment. The main reason for this is believed to be that an uncertainty about who to contact, and the effort needed to carry out the activity.

To facilitate an active participation among citizens the project aimed to develop IT-services that increased citizens' possibilities to actively influence and improve the society. The development of these services was carried out in an interactive manner in cooperation between citizens, companies, and authorities.

The SMART-project had three different, but intertwined purposes:

- to give product-, place-, and service developers the opportunity to engage citizens and user groups in their change-, quality-, and innovation processes,
- to give citizens and individuals the opportunity to engage in these processes regardless of development process,
- to create opportunities for a dynamic region where boundary crossing cooperation becomes usual in the change processes on all levels from product development to community building.

The process of this project is divided into three different activities, systems development, mobile communication and a pilot test. In this paper we report on the systems development activity in which the phases environmental analysis, business modelling, needs analysis, systems specification, and development is included. We especially pays attention to the needs analysis phase in which we have been mostly involved.

To facilitate a participatory approach the project is set in a Living Lab context. Living Labs is an environment aiming to facilitate the interaction process between companies and their intended user groups. The goal is to, in close cooperation between involved stakeholders, develop product and services that users really want and need. The foundation of Living Labs is the involvement of four different

stakeholders in innovation processes; government, companies, researchers and end-user representatives. With this approach the innovation system becomes human-centric, in contrast to technology-centric. The purpose of a Living Lab is therefore, to enhance innovation, usefulness, and usability of IT applications in society (Eriksson, Niitamo, and Kulkki 2005).

The Living Labs concept refers to methodologies where innovations, such as services, products, or application enhancements are created and evaluated in real-world environments. Humans are in focus in the different roles they might have during a day, such as a citizen, user, consumer, a patient, or an employee. The Living Lab activities also go around the clock, this means that users can test an innovation in their private context in real usage situations, hence the users gain understanding of a new product or service function and fits into their usage context (Eriksson, Niitamo, and Kulkki 2005; Holst and Mirijamdotter 2007; Ståhlbröst 2006).

Needfinding and Requirement Specification

Traditionally, systems development processes include the process of establishing requirements. This process is defined as the most important phase within systems development since errors made during this phase have a high impact on the final system (Flynn and Jazi 1998; Dennis, Wixom, and Tegarden 2002; Fitzgerald, Russo, and Stolterman 2002). In the process of defining requirements, these may never be fully understood since the level of communication between users and developers concerning the domain are low. Other problems in the requirement specification process can be that developers and development methods tend to assume that requirements are completely known in the beginning of the requirement process and never change (Dennis, Wixom, and Tegarden 2002; Fitzgerald, Russo, and Stolterman 2002; Flynn and Jazi 1998). This is not true, users change their requirements as they gain more knowledge and insights into possible solutions (Dennis, Wixom, and Tegarden 2002). These mentioned problems with focusing on requirements have inspired us to broaden the perspective and to search for users needs as a base for the requirements. The process of discovering user needs are important for three main reasons (1) human needs lasts longer than specific suggestions for solutions, (2) needs are opportunities for design, not guesses of the future, (3) human needs provide a roadmap for future designs (Oulasvirta 2005; Patnaik and Becker 1999).

When performing a study of user needs it is important to keep in mind that users are not the ones to explicitly communicate their needs of new technological solutions. Users might have needs they are not aware of, or cannot express, and they might not have knowledge about adequate technologies (Faste 1987; Hyysalo 2003; Salovaara 2004). To collect data about requirements related to a specific product is easier since the users have something to relate to (Vidgen et al. 2002), but in our case the focus has been on future solutions, hence asking users to explicitly declare their needs of a product that do not exist is impossible. Finding user needs can be described as a paradoxical activity, since what is sought for is a circumstance where something is missing (Faste, 1987). Preece et al (2002) state

the one way to identify users needs is to study past and current behaviour. Traditionally, corporations have used market research methods, such as surveys, to investigate users' needs. Surveys have worked well in quantifying customers' preferences but they cannot really help in discovering new needs since these might not esteem from existing applications. In our studies the aim has been to stimulate the users to tell as rich stories as possible about their situation and then from these stories elicit their needs (Ståhlbröst and Holst 2006; Holst and Ståhlbröst 2005).

Field Inquiry

To gain understanding of the potential users and their context we use focus group interviews as the main data-collection method. Focus groups stimulate the creation of interactive communication among newly constituted conversation groups that share characteristics of interest (Bloor et al. 2001; Wibeck 2000) and are especially appropriate for studying people's views or attitudes about a certain phenomenon. They generate a broader scale of ideas and views compared to traditional one-on-one interviews (Wibeck 2000) and create a situation in which participants can validate and discuss each others' perspectives and experiences. In the interviews we also often use scenarios (Bodker, Kensing, and Simonsen 2004; Bødker 2000; Carroll 2000) as stimuli. Scenarios can be used in two different ways: either scenarios can be presented to the users in order to help them get started in their process, or one can ask the users to describe a scenario.

In this study, six focus group interviews were carried out with participants selected from the Living Lab community. The focus of the interviews was to discuss citizen's experiences and thoughts related to communication with municipalities and governments. These groups involved between one to six participants. In these groups, both women and men were mixed and their age spanned between 18-50 years. In each focus group, the aim was to stimulate the citizens to talk as much as possible with each other. The stimuli material we used in these focus groups was scenarios related to communication with authorities, alarm, and suggestions for improvement of society. The focus group discussion went on, and whenever the discussion stopped, we introduced a new theme or question. These focus group interviews lasted between one to two hours. Three of the focus groups were carried out with citizens from a larger city and three groups were carried out with citizens from smaller cities. The reason for this approach was an interest to investigate if the citizen's communication with local authorities differed between large and small cities. In this study, we could not identify any differences in their communication patterns with local authorities between large and small cities; hence, the results from the interviews will be presented as a whole.

Eliciting User Needs from Users Expressions

In the process of understanding what users needs, the analysis of the material from the study was separated into two stages of analysis; a vertical and a horizontal analysis (Thomsson 2002). The vertical analysis is related to the needs elicitation while the horizontal analysis is linked to the clustering of needs. Due to this the former will be described in this part while the later will be described in the subsequent part.

In the vertical analysis, each interview was first analysed separately and open, without using a framework for analysis, searching for statements related to needs, problems, goals, requirements, solutions, etc. Thereafter, the identified statements within each interview were analysed using Reiss 16 motivators (Reiss 2004) as a framework to support the identification of needs and to cluster them into categories. Below we give a few illustrations of this process.

Statement 1

In a discussion on how the citizens viewed the opportunity to be actively involved and give suggestions to authorities, and how important this was to them, one citizen said:

“You need to feel that you are *involved* and have the *power* of your own life; that is important”.

This represents a clearly defined need statement, pointing to the importance of power. Here, power is related to the possibility of having influence over their own life, rather than having influence over other people. The meaning of involvement is more uncertain and can be related to status and the desire for social standing and attention; social contact and a desire for peer companionship; or idealism and the desire to improve society.

Based on this statement we added the requirement that the future solution must offer possibilities to choose different mediums and offer opportunities for information about what has happened with their specific matter.

Statement 2

In relation to the functionality of any future solution for citizen involvement one of the citizen said:

“I just want to pick up my phone, make a short video recording, add a voice message and then just send it away”.

This statement does not directly express a need, but rather a preferred process or work flow. Analysing the statement and the context in which it was made we see a close relation to the motivator saving since the statement indicates the importance of efficiency through frugal use of time.

It is also a good example of the fact that from a design perspective, it is the contextualisation of the motivators, desires, and intrinsic feelings that gives the direction or design implication, not the motivators as such. The intrinsic worth of the motivators is that they help us to cluster user needs and stimulate reflection on other possible features that might address the same motivator, but in alternatives ways.

Based on this statement we added the requirement that the final system should support the use of different types of data, such as video recordings, voice messages and pictures. In addition, it should be easy to use. Related to this expression, the log-in procedure became focused on creating a log-in procedure with as few steps as possible.

Statement 3

In relation to the ongoing discussion about alarms one citizen said:

“If I am to pick up the phone and give a suggestion for improvement in society, I can not be hindered by whether I have money on my cash card or not. If there are no hinders, then I would make the call.”

This statement does not either express a direct user need but rather a condition that need to be fulfilled for this person to report suggestions for improvement to the municipality. However, analysing the statement we interpreted it as a representation of the motivator saving, since it point to a desire for a smooth and easy process, as well as to an economic aspect. Here, frugality is represented both in relation to time and in relation to money. Reporting a suggestion for a person that cannot use the mobile phone becomes a more cumbersome activity.

Based on this statement and our interpretation of its underlying rational we added the requirement that the service should be free of charge, since such a requirement would assurance a smooth and easy process as well as address the economic issue.

Statement 4

In relation to our discussion about the citizen’s experiences of their contacts with local government and authorities one of the citizens said that:

“You do not know who to contact, or where to turn, and when you reach someone you usually get the response ‘No, it is not me you should talk to, wait and I will connect you’. Often this pattern is repeated so after a while you just give up.”

This statement reflects a problem or frustration, not a clearly started need. In our analyses we chose to relate it to the motivator saving since it represent a tedious and time consuming process, instead of a smooth and time efficient one.

This statement resulted in the requirement to offer a possibility to search municipality web-pages in order to find the right person dependent on her/his competence, knowledge and responsibility area.

Statement 5

Aiming to identify needs by studying past behaviour we discussed how the citizens usually communicated with local authorities and governments when leaving suggestions, ideas or reporting an alarm about something. A common expression in this discussion can be illustrated by the following citation.

“Today, I have no idea where to turn to with my questions, suggestions and alarms. So absolutely, a fixed place or number I could turn to would be perfect, and above all any solution must have a high level of simplicity.

This statement contains a problem, a suggestion and a condition, but no explicitly expressed need. Here, we also selected two different motivators, order

and saving as representing the underlying needs of the respondent. Order, since the respondents statement that she does not know where to turn or how to elicit this information indicates that the web page of the municipality is not ordered in a satisfactory way. Saving since the respondent says that the solution need to be simple, which we interpret as easy to use.

This statement resulted in the requirement of consistency between web and mobile usage. Independent of channel, the address, appearance and procedure should be the same.

Clustering User Needs

In the horizontal analysis, the selected statements the vertical analyses of all interviews were related to the motivator which the authors viewed as most salient in the text bearing in mind the context in which it was said. After this all statements related to the same motivator was clustered into one group. This illustrates how the same motivator can take many different forms of expression depending on personal, situation or subject, and context. Below a few examples of this process is given.

Idealism – The motive behind this motivator is the desire to improve society including altruism and justice. The intrinsic feeling related to this is compassion.

The motivator idealism is a primary motivator for the project as a whole. It is also a primary motivator for the citizens and the main reason for why they want to interact with the municipality; they want to improve society. The citizens also stress the importance of a technical solution that is democratic when government aims for citizen interaction. For them this means equal access to the system regardless of disability, age, or technology. Besides this the citizens also say that local and central government must clearly show commitment and a will to actively interact with citizens for them to feel motivated to take part in this interaction. It must be worth while. This last part can be related to the motivator power and the desire to have influence, to feel that ones effort makes a difference.

Order – the motive behind this motivator is the desire to organize (including desire for ritual) and the intrinsic feeling is stability

The citizens express a need for order in two different ways. Firstly, they convey a desire to easily find the person responsible for their particular subject. Not knowing who to contact or how to proceed creates an uncertainty hindrance and is said to be a main reason for why they decide not to contact the authority and present their question, request or suggestion. The uncertainty can be understood from at least two different perspectives or main motivators; saving or tranquillity. From a savings perspective it becomes too laborious, and they are often not willing to spend the time required to create the intended contact. From a tranquillity perspective this unclear responsibility structure creates a feeling of uncertainty.

Secondly, when in contact with local or central authority they express a need for order. They want the authority to deal with their matter in an orderly fashion. The matter should be well documented so it can be referred back to in the next contact, since they do not want to start from the beginning in each contact. Here, three different main motivators can be conceived of, saving and tranquillity based on similar discussions as the one above, and order since a well structured process gives stability and ensures that all citizens are treated in a similar and equal way.

Independence – the motive behind this motivator is the desire to be autonomous and the intrinsic feeling is freedom.

According to the citizens their motivation to communicate suggestions or alarms is often closely linked to the specific moment when, or context were, they get an idea, or observe something they want alarm. This is especially so in relation to alarms. Hence, their motivation is quite context and time dependent; as time passes, or they move away from the particular context, the motivation decreases. This implies that any future solution must support mobile solutions and cannot be limited to one communication channel; it must support direct, mobile, and easy input regardless of technology. Here, the citizens talk about technology enabling them to be more independent of place and time, and about being free to use whatever technique they want. In the study we related the motivation to communicate suggestions and alarms to idealism and power while the technology must support independence and be possible to use whenever and wherever the citizens needs it.

Saving – The motive behind this motivator is the desire to collect and the value of frugality. In this motivator, the intrinsic feeling is ownership.

This motivator was one of the most central for the respondents. Saving was usually expressed in the form of efficient and smooth processes, time savings, and monetary frugality through cheap services. It is also a motivator that is closely linked to the anticipation on IT in development work. The main purpose of most IS/IT products and services is to improve the effectiveness and/or efficiency of different activities.

Acceptance – the motive behind this motivator is the desire for approval. The intrinsic feeling is self-confidence.

Many citizens expressed a need for feedback on their suggestions handed to an authority. They said that they wanted to be taken seriously and to get approval of their ideas. In this context, this means that they want information about how their suggestions were judged and handled.

An alternative interpretation of these statements can be that they want feedback as a confirmation of themselves and the quality and importance of their suggestion. Viewed this way the statements indicate the motivator status, rather than acceptance.

Tranquillity – the motive behind this motivator is the desire to avoid anxiety and fear and the intrinsic feeling is safe and relaxed.

The citizens express a need for tranquillity in relation to alarm situations. They said that they want to avoid situations that create fear, such as walking through a

pedestrian subway with broken lights, or visit multistorey car parks at times when there are few visitors. In situations like these they want the ability to alarm direct on sight. In relation to these situations the citizens also said that they would agree to be supervised by camera supervision for example, if it could increase their security.

Social contact – the motive behind this motivator is the desire for peer companionship (a desire to play) and the intrinsic feeling is fun.

The motivator of social contact is expressed as the opportunity to discuss and develop their own, and others, ideas and suggestions for improvements in society. The citizens also mention interactive municipality web pages, with discussion forums, where politicians participate in discussions about suggestions for improvement of the society, or discussion about other local issues needed to be discussed.

The citizens also say that personal contact with local and central authorities feels important when the matter is related to a family matter or a matter of private nature. This type of social contact does, however, not fit the intrinsic feeling of fun and play, but can rather be interpreted and explained by motivators such as tranquillity, or status. Status here should, however, be seen as self-importance from an equality perspective, meaning I, my family, or my matter is also important.

Curiosity – the motive behind this motivator is the desire for knowledge and the intrinsic feeling is wonder.

In the SMART project, the motivator *curiosity* was related to the citizens' needs of getting answers to their questions when they are in contact with local and central authorities. The citizens also wanted to have the opportunity to ask simple questions on the municipality webpage and get reliable answers from specialists. In addition, the citizens wanted to be informed that they are welcome to leave suggestions or to alarm about certain issues in the society.

Final remarks and reflections on the findings

Based on the trends and weaknesses found in present literature related to user needs this paper aimed to contribute to the field by presenting a case study focused on increasing citizens' involvement in municipality matters. More specifically, we present a method for eliciting, structuring and understanding user needs.

The findings from the study can be divided into three clusters. The first is related to the technical solution. Here, we have found that for the citizens to be motivated to use a technical service for interacting with local and central authorities the solution must: be mobile; provide a diverse set of communication channels; and be able to handle different types of data, such as text, audio, and visual data. It must also be free of charge, smooth and easy to use, provide feedback about where the matter is in the management process, and information

about eventual implementation. Finally, it must provide all citizens equal access to the system regardless of disability, age, or technology.

The second cluster relates to the needs expressed by the citizens and/or interpreted by the authors. They give an indication of needs that citizens consider important and that need to be considered when developing e-services geared at e-participation and involvement between citizens and public authorities. The motivators that was said to stimulate the citizens to interact with public authorities were idealism power, status, acceptance, curiosity and tranquility, while the motivators that have influenced the design of the implemented system most is saving, order, and independence. We also see a difference between the motivators that are important for a citizen to leave a suggestion compared to communicating an alarm. For suggestions it is mainly idealism power, status, acceptance, while alarm is strongly related to the motivator tranquility and idealism. Curiosity on the other hand is related to receiving information, rather than provide information. By the exercise, or illustration, of how user statements have been interpreted into user needs and motivators we want to illustrate that people do not express clearly stated needs. Rather, their contributions include a mix of needs, suggestions, conditions, and problems. Due to this the analyses of their statements becomes very important, and in order to harvest the potential of identified needs or underlying rationalities of different types it must be possible to identify them separate them from the rest of the text.

The study also reveals the dual relation between safety and control. This was particularly noticeable in the discussions related to alarm and emergency situations. Here, the citizens expressed both willingness and a wish to be supervised by, for example, camera supervision in certain milieus, such as dark tunnels and empty car parking buildings. In other situations they viewed supervision as something quite negative.

The third cluster of findings relates to the method and framework used to elicit, cluster and understand user needs. The most important finding and conclusion here is that the main strength of the framework is the discussion and reflection it generates in relation to different statements by the potential users. These discussions generated interesting debate on what the meaning of a statement might be, and as such it point to uncertainties in statements and their meanings that need to be investigated further. This debate can be seen in the example related to the motivator saving. Further, by choosing three different statements, related to the motivator saving, which generated three different requirements, we also wanted to show that in all our studies so far there have been an uneven distribution among the motivators. That is, a few motivators were chosen frequently, while some were not addressed at all. Hence, the framework has not been used to identify general needs among citizens, but to understand the context specific occurrence of different needs and motivators. The discussions have also generated interesting ideas for new possible requirements or functions of the developed product or service.

Acknowledgements This work was supported by EU's Objective 1; The Swedish Agency for Innovation Systems (Vinnova); and Centre for Distance Spanning Technology (CDT), Luleå University of Technology.

References

- Bell, Genevieve., and Paul. Dourish. 2007. Yesterday's Tomorrow: Notes on Ubiquitous Computing's Dominant Vision. *Personal and Ubiquitous Computing* 11:133-143.
- Bergvall-Kåreborn, B., Marita. Holst, and Anna. Ståhlbröst. 2007. Creating a New Leverage Point for Information Systems Development. In *Advances in Appreciative Inquiry - Designing Information and Organisations with a Positive Lens*, edited by M. Avital, R. Boland and D. Cooperrider: Elsevier.
- Bloor, M., J. Frankland, M. Thomas, and K. Robson. 2001. *Focus Groups in Social Research*: Sage Publications.
- Bodker, Keld., Finn. Kensing, and Jesper Simonsen. 2004. *Participatory IT Design - Designing for Business and Workplace Realities*. Cambridge: The MIT Press.
- Bødker, S. 2000. Scenarios in User-Centered Design - Setting the Stage for Reflection and Action. *Interacting with Computers* 13 (1):61-75.
- Carroll, J M. 2000. Introduction to the Special Issue on "Scenario-Based Systems Development. *Interacting with Computers* 13 (1):41-42.
- Cooperrider, D L., and Michel. Avital, eds. 2004. *Advances in Appreciative Inquiry, Constructive Discourse and Human Organisation*. Vol. 1. Oxford: Elsevier.
- Cooperrider, D L., and Diana. Whitney. 2005. *Appreciative Inquiry - A Positive Revolution in Change*. San Francisco: Berrett-Koehler Publishers
- Cooperrider, D L., Diana. Whitney, and Jacqueline M. Stavros. 2005. *Appreciative Inquiry Handbook*. San Francisco: Berrett-Koehler Publishers.
- Dennis, A, B Wixom, and D. Tegarden. 2002. *Systems Analysis & Design - An Object-Oriented Approach with UML*. New York: John Wiley & Sons, Inc.
- Ericson, Å., and A. Ståhlbröst. 2005. In Search of Innovation - Grasping the Concept of Needs. *International Journal of Technology, Knowledge and Society* 2 (4):35-49.
- Eriksson, M., V.P. Niitamo, and S. Kulkki. 2005. State-of-the-art in Utilizing Living Labs Approach to User-centric ICT innovation - a European approach: Centre of Distance Spanning Technology at Luleå University of Technology, Sweden, Nokia Oy, Centre for Knowledge and Innovation Research at Helsinki School of Economics, Finland.
- Esbjörnsson, M., O. Juhlin, and M. Östergren. 2004. Traffic Encounters and Hocman - Associating Motorcycle Ethnography with Design. *Personal and Ubiquitous Computing* 8 (2):92-99.
- Faste, R. 1987. Perceiving Needs. Paper read at SAE Future Transportation Technology Conference and Exposition, at Seattle, Washington.
- Fitzgerald, Brian., Nancy L. Russo, and Erik. Stolterman. 2002. *Information Systems Development - Methods in Action*. London: McGraw Hill.
- Flynn, D, J., and M Jazi, D. 1998. Constructing user requirements: a social process for a social context *Information Systems Journal* 8:53-83.
- Ha, Tae Seung., Ji Hong. Jung, and Sung Yong. Oh. 2006. Method to Analyse User Behavior in Home Environment. *Personal and Ubiquitous Computing* 10:110-121.

- Holst, M., and A. Mirijamdotter. 2007. Interaction in Cross-Functional Team Work: Making Sense Through the POM Model. *Systems Research and Behavioral Science* Accepted for publication.
- Holst, M., and A. Ståhlbröst. 2005. Entrepreneurial Knowledge Community - Report from interviews with incubators and young entrepreneurs in the EKC project. Luleå: Division for Information System Sciences.
- Holtzblatt, Karen. 2005. Customer-centered Design for Mobile Applications. *Personal and Ubiquitous Computing* 9:227-237.
- Hyysalo, S. 2003. Some Problems in the Traditional Approaches to Predicting the Use of a Technology-driven Invention. *Innovations* 16 (2).
- Kaasinen, Eija. 2003. User Needs for Location-aware Mobile Services. *Personal Ubiquitous Computing* 7 (1):70-79.
- Kankainen, A., S. Tiitta, and M. Rantanen. 2003. Exploring everyday needs of teenagers related to context and presence aware mobile services. Paper read at proceedings of Human Factors in Telecommunications.
- Kankainen, Anu., and Antti. Oulasvirta. 2003. Design Ideas for Everyday Mobile and Ubiquitous Computing Based on Qualitative User Data. In *User Interfaces for all*, edited by N. Carbonell and C. Stephanidis. Berlin: Springer-Verlag.
- Norum, Karen E. 2001. Appreciative Design. *Systems Research and Behavioral Science* 18:323-333.
- Oulasvirta, A. 2005. Grounding the Innovation of Future Technologies. *Human Technology* 1 (1):58-75.
- Patnaik, Dev., and Robert. Becker. 1999. Needfinding: The Why and How of Uncovering People's Needs. *Design Management Journal* 10 (2):37-43.
- Preece, J., Y. Rogers, and H. Sharp. 2002. *Interaction Design: Beyond human-computer interaction*. New York: John Wiley & Sons, Inc.
- Reiss, S. 2000. A Mindful Approach to Mental Retardation. *Journal of Social Issues* 56 (1):65-80.
- . 2001. Secrets of Happiness. *Psychology Today* January/February:50-56.
- . 2004. Multifaceted Nature of Intrinsic Motivation: The Theory of 16 Basic Desires. *Review of General Psychology* 8 (3):179-193.
- . 2005. Human Individuality and the Gap Between Science and Religion. *Zygon* 40 (1):131-142.
- Salovaara, A. 2005. *UCPCD in short* 2004 [cited 2005-05-12 2005]. Available from <http://www.hiit.fi/u/asalovaa/articles/ucpcd-in-short.html>.
- Ståhlbröst, A. 2006. Human-Centric Evaluation of Innovation, Department of Business Administration and Social Sciences, Luleå University of Technology, Luleå.
- Ståhlbröst, A., and M. Holst. 2006. Appreciating Needs for Innovative IT Design. *International Journal of Knowledge, Culture and Change Management* 6 (4):37-46.
- Thomsson, H 2002. *Reflexiva intervjuer*. Lund: Studentlitteratur.
- Tiitta, S. 2003. Identifying elderly people's needs for communication and mobility. *Include* 2003 7 (March):266-271.
- Wibeck, V. 2000. *Fokusgrupper - Om fokuserade gruppintervjuer som undersökningsmetod*. Lund: Studentlitteratur.
- Vidgen, Richard., David. Avison, Bob. Wood, and Trevor. Wood-Harper. 2002. *Developing Web Information Systems*. Oxford: Butterworth-Heinemann.

Scenario Planning And Personas as Aid to Reduce Uncertainty of Future Users

Erik, A.M. Borglund & Lena-Maria Öberg
Departement of Information Technology and Media
Mid Sweden University
erik.borglund@miun.se, lena-maria.oberg@miun.se

Abstract

Information systems are often designed to fulfill certain user needs, users that are intended to use the information system. For electronic records future use can be unknown. As electronic records may be preserved for very long time it would be beneficial to identify future use to be able to design recordkeeping systems that meet future requirements. An electronic record can never be changed or altered during its preservation, and implicit must at creation be captured in a way that it also meet future needs. In this research we propose that scenario planning and the interaction design technique personas together form a method that could reduce uncertainty about future use of electronic records in design of recordkeeping system. The proposed method was evaluated in an experiment like interpretative research. The method was applied in the police domain, which consists of several recordkeeping systems which content should be preserved forever. The research indicate that scenario planning and the scenarios that are outcome of the method could be used to design personas, from which then future use of electronic records could be derived. The scenarios must be very rich and could consist of many mini scenarios in which the personas could act.

Keywords: Electronic record, Information system design, Personas, Recordkeeping systems, Scenario planning

Introduction

Information systems (IS) are most often designed to fulfill certain needs amongst users, needs resulting in information system user requirements something well known since the many years. Sundgren (1995; 1996) used this knowledge to argue for that many of current information system development methods rest on a set of assumptions, which includes that the information system have users with needs that are known at time for development of the information system. The work with capturing the user needs are embedded in modern development techniques and is transparent in well used literature in information system development and design (see amongst many Mathiassen, Munk-Madsen, Nielsen, & Stage, 2001; Pressman & Ince, 2000). Techniques to involve users in the development processes such as participatory design (e.g. Kensing & Blomberg, 1998) just strengthen the importance the user and their needs have on the outcome of an information system. But not all information systems have their user known at time for development. Sundgren (1995; 1996) defines such system as information systems with partially unknown purpose, which is information systems that e.g. have important future users not known in advance, and that requirements may shift and alter during the information systems lifetime.

In research on recordkeeping¹, in mainly public organizations, recordkeeping² systems have been found to be information systems with partially unknown purpose (E. Borglund, 2006; E. A. M. Borglund, 2007; E. A. M. Borglund & Öberg, 2007). Because of legislations records in a public organization must be preserved for long time. To be able to serve as evidence over activities the record must be kept unmodified (see e.g. International Standards Organization, 2001; Reed, 2005; Thomassen, 2001). A record can therefore be interpreted as original evidence over some activity.

In Borglund (2006), Borglund (2007), and Borglund & Öberg (2007) records have been found to be used in ways that not was meant or known when the record was created. A record must at creation fulfill stated and implied needs i.e. record requirements, to be able to maintain the evidential value (c.f. Duranti, 2001; Reed, 2005) For example a police report, can never be changed after it is finished. If there is a need to change the report this is recorded on a complementary police report linked to the first one. In the court hearing there can be no doubt that the police report is the original and that it not has been changed.

In design of recordkeeping systems, future use of electronic records³ implicit must be taken into consideration to give the system adequate functionality that

¹ An organized and structured way of managing records from creation of records to destruction or long-term preservation.

² Information systems involved in the management of records.

³ Records born digital

support future electronic records use. Knowledge about future use of electronic records is therefore part of the design process of such systems. Consequently based upon above introduction this research has been guided by the following research question:

How can future and unknown use of electronic records be captured and identified? And the aim of the paper is to present a methodological proposal to reduce uncertainty of future use of electronic records.

The problem with unknown future use has in this paper been applied in the recordkeeping system domain. This does not make the proposed method to be unusable in design of other types of information systems, which manage information with unknown future use.

The remainder of this paper is organized as follows; first we present a frame of references followed by the research method applied. Then is the actual result from the research presented followed by a discussion. The paper ends with a conclusion and outlines for further research.

Frame of references

By doing an rather quick literature search in major academic databases one can find the existence of several techniques usable for forecasting of the future, amongst many; Trends exploration, Experts, Simulation modeling, and scenarios, described in e.g. Smith, Allen, Stewart, & Whitehouse (1987). Scenarios have been applied in design of IS (e.g. Carrol, 2000; Carroll, 2000), which also is the case for simulation (see e.g. Palmius, 2005). The Delphi method is another method used in information system research to assist forecasting (Okoli & Pawlowski, 2004). In the Delphi method a group of experts, representing the “oracle in Delphi”, work together and as experts forecast the most likely future. Scenarios reduce uncertainty by making the future structured into “predetermined and uncertain elements” (Wack, 1985a, p. 140), and scenarios have in military been used as basis for strategic decisions. Eriksson & Ritchey (2005) is critical against a traditional development of scenarios, as they characterize as a process performed by a “Bunch Of Guys Sitting Around a Table”. Instead Eriksson & Ritchey (2005) propose to use Morphological analysis for developing scenarios, a method usable for complex problem with non-resolvable uncertainties. Scenario planning is another method to develop scenarios following a more structural process (Bell, 2000; Lindgren & Bandhold, 2003; Schoemaker, 1995; SHELL, 2003).

Scenarios can be used in a variety of situations: “to present and situate solutions, to illustrate alternative solutions, to identify potential problems” (Bødker, 2000, p. 63). Scenarios can be used to describe work practice (Carrol, 2000), and together with personas have been visualizing work practice in a less uniformly way (Nuldén & Borglund, 2006). Scenarios makes it possible for a designer to reflect in the design phase, for example on how an information system is going to

be used (Carroll, 2000). The success of reflection in a design situation has been argued by Schön (1983). Scenarios contains: "(1) actors, (2) background information on the actors and assumptions about their environment, (3) actors' goals or objectives, and (4) sequences of actions and events." (Go & Carrol, 2004, p. 46). Scenarios can strengthen the whole design process by providing a common language for all participants in the process (Go & Carrol, 2004). In information system design scenarios are often found to be stories or narratives about actor activities to enrich the understanding of user needs and user behavior (Carrol, 2000; Lindgren & Bandhold, 2003; Schoemaker, 1995). Erickson (1996) suggest that storytelling is very useful for interaction designer to use when a common ground is going to be established between actors involved in a design situation. Stories enable a basis for communication, and interaction between actors, which can be useful, when design is more than just making things. Design is a social collaborative work between actors and storytelling can be used to better describe and understand the complexity and richness of an organization where an information system is going to be implemented (see e.g. Erickson, 1996).

When it comes to the specific problem addressed in this paper a set of different proposals of methodological aid is found. On suggestion to reduce the uncertainty of users, and user needs is to use scenarios, use scenarios where both known and imaginable users can be identified, and their needs can be definable (Sundgren, 1996). Story telling, and narrative methods can be used to identify known and imaginable users during the design and development process (Erickson, 1996). Axelsson (2006) suggest that use of personas (e.g. Cooper, 2004; Pruitt & Grudin, 2003) can be fruitful to reduce the problems with identifying unknown users in database modeling. Personas and scenarios in combinations with each other have been evaluated and tested with success to capture unknown user requirements for embedded software meant to be used in e.g. telephones (Aoyama, 2005).

Proposed method components

In this paper we have chosen to use scenarios as basis to visualize a possible future and the method of scenario planning (Lindgren & Bandhold, 2003; Schoemaker, 1995; SHELL, 2003; Wack, 1985a, 1985b) to develop the future scenarios. In a future scenario, future users and actors are present. The interaction design technique Personas (Cooper, 2004; Pruitt & Grudin, 2003) is a technique to develop fictive persons i.e. information system user archetypes. Persona is used to present user archetypes derived from the future scenarios, to be used in design in e.g. identification of user requirements.

In this paper we want to be able to reduce the uncertainty in future use of electronic records. Using scenarios can give knowledge about organizational bound electronic records use. Scenarios in practice and research is tested to give support in design situations to understand the complexity and purpose an IS has (Antón &

Potts, 1998), and in at least three disciplines: strategic management, human computer interaction, and software and system engineering, suited to identify future states (Jarke, Bui, & Carroll, 1998). The choice of using scenario planning has been taken both upon the accepted use of scenarios in IS design (e.g. Carrol, 2000; Carroll, 2000), but also when scenarios in research have been suggested as a working technique to identify unknown users (Aoyama, 2005; Sundgren, 1996). In this research the scenario planning will aid us to develop a set of future scenarios. There are many ways to develop scenarios such as ethnographical field studies, participatory design, and transformation (a form of brainstorming) (Carroll, 2000), but scenario planning aims to develop scenarios for a possible future. Scenarios planning also result in scenarios based and developed upon combinations of uncertainties. Scenario planning is also a very well described step by step method that are easy follow, which can reduce the risks of too much guesses in scenario development.

To strengthen design we involved the interaction design technique Personas (Cooper, 2004; Pruitt & Grudin, 2003) into our proposed method. Characteristics of an unknown user must be fictional or hypothetical, which is something that is given by the technique of using personas. The persona can give life to a scenario, and become the actor within the scenario, something we assume can reduce the uncertainty about future electronic records use, and support identification of user requirements. To sum up: A scenario is meant to present a rich picture of a possible future (Lindgren & Bandhold, 2003; Schoemaker, 1995; SHELL, 2003; Wack, 1985a, 1985b). The scenarios are fictive and we have therefore chosen to use personas (Cooper, 2004; Pruitt & Grudin, 2003) as technique to present potential users within the fictive scenarios.

In the following sections personas and scenario planning is theoretical described.

Scenario planning

Scenario planning is a generic term for methods used to create scenarios that makes the future imaginable. The oil company Royal Dutch/Shell is in literature presented as one of the first enterprises that adopted scenario planning at large extent, with great success (Schoemaker, 1995; Wack, 1985a, 1985b). By using scenarios a wide range of data and information is packed in a manageable form that help decision makers to capture the variety of all the possibilities can offer. Another positive result of scenario planning is that the scenarios it self, are possible to present using narratives or storytelling that make them much more easy to understand, and communicate around (Schoemaker, 1995). According to both Schoemaker (1995) and SHELL (2003) is scenario planning a method that give decisions makers a basis for strategic decisions. On strategic level decisions are affecting the future, and without knowledge about the future such decisions would be more like guesses. Strategic planning does not claim to present “the” future, it

gives a set of scenarios that represent a possible future. The Royal Dutch/Shell gives the following definition: "scenarios are stories about the future, but their purpose is to make better decisions in the present" (SHELL, 2003, p. 55). Scenario planning is the method that includes the work to develop the scenarios as well as acting upon them (Lindgren & Bandhold, 2003).

Scenario planning is a method that is possible to follow step by step. The method involves qualitative elements interpreted by individuals, which can result in critique. For example, one important component in scenario planning is to identify trends and factors that affect the problem domain. The trends identified are off course dependent on the individuals working with the scenario planning. The persons involved in scenario planning are affecting the outcome. The scenarios used in this paper have been designed by persons involved in founding the scenario planning method TAIDA (Lindgren & Bandhold, 2003). TAIDA is an acronym for Tracking, Analysing, Imaging, Deciding, and Acting. In the proposed method we does only want to use scenario planning until the scenarios are designed. The acting and organizational decisions taken upon the scenarios are not included in the proposed model. Before a scenario planning project starts the focal question must be identified, and the time span for which the scenarios aims to cover must be identified. T in TAIDA model stands for Tracking, which is a phase where trends, driving forces are identified. In the next step Analysis (A) the trends are analyzed and from the analysis two uncertainties are chosen, which are put into a cross matrix. The uncertainty cross forms four scenario fields (exemplified in fig 2). The scenarios are then designed. For elaborate details of the TAIDA model see Lindgren & Bandhold (2003).

Personas

Personas is a interaction design technique (Pruitt & Grudin, 2003) where fictional users are used in the design. Personas are "hypothetical archetypes of actual users" (Cooper, 2004, p. 124) and are an interaction design technique applicable for information system design. The idea behind persona is that they represent non-existing persons in real life, but they represent intended users of the design object, in our case information system. The characters designed are fictional but their behavior is based on real data. According to Cooper (2004) you have greater success in design targeting a small group instead of a large. Personas enable this small targeting. Designing for any one persona is better than trying to design vaguely for everyone of specifically for oneself (Grudin & Pruitt, 2002). A persona is used as a technique to represent a hypothetical user of the design object. Instead of interact with real persons selected from a large population, the large population is represented by a number of personas, given certain characters. It is necessary that the personas should represent the user of the artifact that is designed, and not someone that only are physical close to the artifact. Personas are claimed to force designers to consider social and political aspects of design that

otherwise often go unexamined (Grudin & Pruitt, 2002). Personas are meant to serve as basis for identifying user needs.

You should name the persona, and give the persona a short life story. Scenarios are a natural component in persona based design and are used to describe situations and events a persona could be part of (e.g. Loke, Robertson, & Mansfield, 2005; Pruitt & Grudin, 2003). It is argued that personas are less effective when they not are complemented with scenarios, scenarios can be constructed around personas, but the personas is supposed to be designed first (Grudin & Pruitt, 2002). Pruitt and Grudin (2003) based their design of personas on existing knowledge and research results of potential users. They limited the number of personas to 3-6 to make them manageable. When designing the persona anecdotes from previous research can be useful to give life to this fictive person (Pruitt & Grudin, 2003).

One critique against personas is that they are not aiding the designer as they intend to do. "A persona is not something that can be placed on the designer's desk to make the user present in the design work." (Johansson & Messeter, 2005, p. 241) Johansson & Messeter (2005) highlights the importance that the persona as a user archetype gives the designers some value as an input to the design process.

How personas has been implemented and used in this research is described in the section about Deriving of Personas.

Method

In this paper we propose that scenario planning together with use of persona could be useful in design of recordkeeping systems, to identify unknown future electronic records. Personas are then aimed to serve as basis for finding and defining user needs. Scenario planning normally ends with decisions and acting upon the actual scenarios (Lindgren & Bandhold, 2003). In this research and in the proposed method we end the scenario planning process when the scenarios are designed and presented in a scenario matrix. From the developed scenarios personas are going to be derived.

Research domain

In this research we apply our proposal in a specific domain, the police domain. This is made upon following arguments: (1) In the police domain there exist many recordkeeping systems, which manage electronic records that are going to be preserved forever. For example the command and control system, and the police report system (E. Borglund, 2005). The information system managing police reports were developed in late 80's and the system does not meet present user needs (Holgersson, 2001, 2005). (2) Personas have been used to describe police work practice by Nuldén & Borglund (2006). In their research the personas was

derived based on empirical data and a temporal structures matrix. The use of personas have been evaluated to be a working method to describe police officers and their use, user need of information and information technology. (3) In 2000 the Swedish National Police Board together with the Swedish public prosecutor of- fice used scenario planning to present four possible scenarios that aimed to in- crease knowledge about the future crime arena in Sweden (Bandhold, Kairos Fu- ture, Rikspolisstyrelsen, & Riksåklagaren, 2001). One underlying motivator was to understand what competence the future police officers and prosecutors needed (Lindgren & Bandhold, 2003).

Research Method

This research rests upon an interpretative approach useful in information system research (M. Myers, 1997; M. D. Myers & Avison, 2002). The proposed method to use scenario planning and personas have been applied and tested in the police domain. The researchers have been active in this work to apply the method in a real life setting, and not only theoretically motivate the proposal.

The research is a joint effort of two researchers. One of them has a rich experi- ence from the police domain, after more than 16 years of active police work. The other has limited knowledge of the police domain. The research has therefore been carried out with a mix between both an inside and an outside perspective.

The process can be seen as an experiment where the proposed method is tested in real life, in a domain for which the method can be useful. The process is visual- ized in figure 1. The use and stepwise verification of the method have been done in one police authority in the Mid Sweden region between January and Mars 2007. Throughout the research data have been collected by interviews, group in- terviews and questionnaires. Different types of data collection techniques have been used at different stages of the research, which is described below. In this research the focal interest has been on results derived from the process of using the proposed method. The actual use of the method in an experimental like way is supposed to give results that can improve the method proposal.

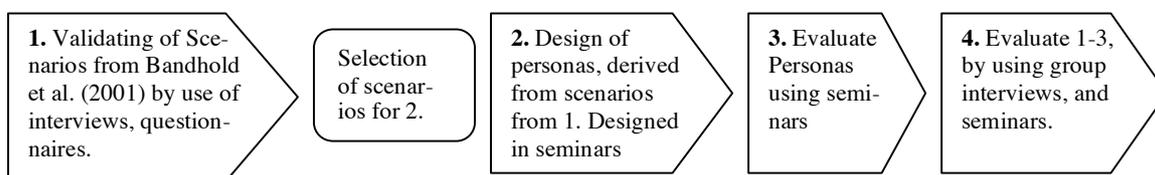


Fig 1. The phases in the research process

One challenge in this research is to evaluate whether it is possible to derive personas from scenarios, and if the personas together with the scenarios can be usable to reduce uncertainty in future use of electronic records and recordkeeping systems. When this research implicit aims to solve a problem, which can be visual

in the future, it is very difficult to evaluate the method at full scale. We have been using the scenario planning, and the four scenarios, that was published in 2001 about the Swedish crime arena (Bandhold et al., 2001) as basis in our research. The scenarios used was forecasting the crime arena in 2007 (Bandhold et al., 2001).

The first step in this research was to verify that the scenarios we intended to use was corresponding with the present situation in 2007. Without a correspondence the whole idea with this method would have been to be revised. This phase was carried out through a two-hour group interview with two senior chief inspectors at the police authority. The group interview was recorded. As complement 7 police officers was given a summary as a printout of the characteristics of the four scenarios presented by Bandhold et al. (2001, pp. 32-33). The police officers were supposed to note what characteristics was best correspondent with the present situation i.e. the year 2007.

The next phase in this research was to derive personas from the scenario that best corresponded with reality i.e. the result from previous phase. The personas was derived by the researchers and were developed together with colleagues that had no or very limited knowledge of police work practice. The personas were police officers that worked in the chosen scenario. The personas was focusing on work practice and information need. Totally two personas was derived and designed from the scenario (Appendix 1).

The derived personas were in the third phase of the research validated in three group interviews at one local police authority. The verification of the personas aimed to verify if the personas and the characteristics of them were corresponding with the scenario from which they were derived, and that the personas were representing archetypes of police officers.

The last and final phase in this research was to analyze the entire process, e.g. to identify requirements for the scenarios, and identify observed obstacles needed to take into consideration improvements of the proposed method.

Validating of scenarios

In (Bandhold et al., 2001) four future scenarios is presented in a matrix (fig 2), scenarios that present a crime situation in the year 2007.

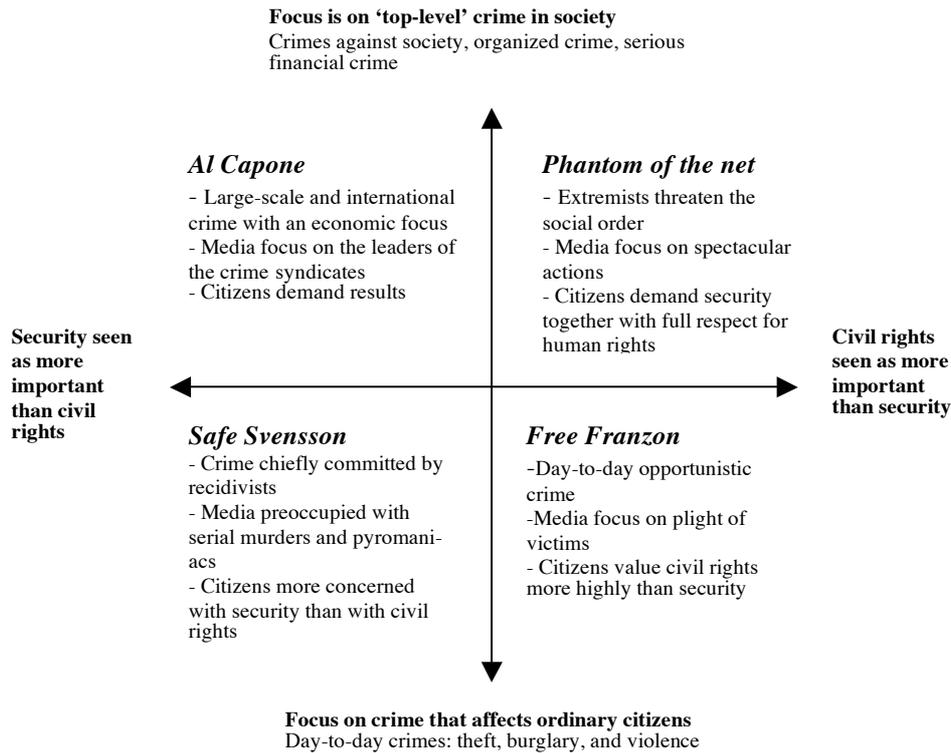


Figure 2. Scenario matrix over crime situation in 2007 (Bandhold et al., 2001, p. 31; Lindgren & Bandhold, 2003, p. 69)

The validation of the scenarios was done at one local police authority as described in the method section. All nine police officers of varied rank and age agreed upon that the scenario *Safe Svensson* was the scenario that best corresponded with the present situation. According to the police officers all four scenarios had parts, which very well corresponded with the present situation. The police officers thought that the scenarios in some parts were too similar with each other and they consisted of small variations. They also commented that there have only been minor changes in the Swedish crime arena since 2000. One area has changed radically. Before 9/11 terrorist was handled by the national secret service and very rare terrorist crimes was affecting traditional police work. But now the fight against terror has been part of everyday policing, something also embedded in two scenarios whose content not were corresponding as well as *Safe Svensson*.

Safe Svensson

This is a summary of the scenario *Safe Svensson*, from (Bandhold et al., 2001, pp. 41-42).

The society has underestimated the effects that came when the cold war ended and the increasing numbers of new democratic nations. Even if the democratizations have been slow, have many crises been avoided in former “hot regions” such as Yugoslavia, North Ireland, and Basque amongst many. Much work is still

to be done, but even if it is not peace all around the world, it is not a full-scale war going on. There has been a dramatic change in the possibilities for police and prosecutors to fight international criminal organizations. The economic crime has also been reduced much dependent on a successful collaboration between European police forces. New international and national regulations that are easier to follow up have made it easier for prosecutors and the police in their work. When it comes to other serious crimes that not are organized the police have gathered a set of hard-earned experiences. In several court proceedings many spectacular trials against serial killers and psychopaths have resulted in a more successful policing. Several arrests the last couple of years are evidence of this success. Paradoxically this has resulted in that the ordinary citizen is feeling more insecure than ever. The awareness that there exist many mentally deranged persons in the society who stands for the majority of the crimes of violence have increased. Many citizens are afraid and imply that the police and prosecutors should act. Media is focusing on everyday crime and less on classical “bad guys”. It is more common that victims are in focus in media, than criminal persons. The situation in society is described, as that the enemy can be everywhere. The picture where threat and violence is present for every citizen is broadcasted almost every day. Media is one reason that many are feeling insecure both in cities and in the countryside. Voices have been raised that the police must be tougher. Surveillance cameras, phone tapping, and tracking seem naturally. “Better to be watched by a camera than raped and buried” is a common opinion. The acceptance of surveillance is probably dependent on that many citizens think that the police and prosecutors only are interested in criminals and not ordinary citizens. The society implies that the police and the prosecutors must reduce the suffering victims feel, and they must put as many criminals as possible behind bars, that threaten the society and the citizens’ freedom.

Deriving of personas

The personas were designed derived from information found in the scenario *Safe Svensson*. In literature personas is suggested to be designed based on a rich material, captured from e.g. ethnographic studies, and interviews (Cooper, 2004; Grudin & Pruitt, 2002; Pruitt & Grudin, 2003). When we aim to design personas from a future scenario those tools are not available. We derived the personas by making a categorization of key components in the scenario *Safe Svensson*.

Two personas were designed, and they aimed to result in what Cooper (2004) defined as primary personas, i.e. archetypes of users. The main categories which we derived from the scenario was (1) trans national organized criminality and (2) local every day criminality.

In this research the work with design we began to give the personas a name, a work family history and a brief background of their police career. They were

given a work position that corresponded with the two categories. I.e. one of them is working with police work involved with trans national organized criminality, and the other with local every day criminality. Then the persona was given a more detailed description about their work practice. We did not because of time limitations have possibilities to make a poster of the persona with a picture on, as described by (Cooper, 2004; Grudin & Pruitt, 2002; Pruitt & Grudin, 2003).

The personas was influenced by the personas designed by Nuldén and Borglund (2006). The work with design of the personas was done in collaboration between the two researchers. The researcher with police experience acted as source of details and the other researcher acted as moderator, asking questions to make the persona understandable for persons outside the police. The latter is important if the persona really should be able to describe a fictive future user of electronic records.

The two designed personas are found in appendix 1.

Verification of Personas

The verification of the Personas was done with a purpose to verify if the two designed personas could act as police officers in the scenario *Safe Svensson*. The verification was done in small group settings at the police authority. Six police officers were giving the scenario and the personas written in Swedish. After they had time to read scenario and personas they were interviewed two and two in an open interview where the following questions was raised:

- Are the two personas possible archetypes of police officers in the actual scenario?
- What is needed in a scenario that describes future police work so that it can be useful to derive police archetypes?
- What is needed in a scenario to visualize information need?

Before the interviews begun, the police officers were given a short brief over the purpose of the study, and that the persona aimed to be used as tools to design recordkeeping systems, and such systems were exemplified.

All police officers thought that the two personas were archetypes for police officers possible to find in a context or criminal arena represented by the scenario *Safe Svensson*. The comments they had were about persona one, Karl. Some police officers thought he were using technology in a way that they did not thought was possible.

Number one, he seemed to be quite futuristic. Is it possible to use information systems across nations as the text describes? I mean it might work, but I doubt that it really does. (Police officer M)

The police officer M, who gave above comment, had on the other hand not any comments about whether persona one really could exist and be derived from scenario *Safe Svensson*. His comments were based on his own assumption that Swedish police information systems cannot have been so useable that they enable access to data/information sources abroad.

The question about how scenarios should be formulated to best describe future police work was resulting in longer silence in all three interviews. But the common suggestion was that a scenario should have more details. For example in the scenario *Safe Svensson* two obvious categories were identified: First that the organized crime had been under control based on an efficient collaboration between police forces. Second the large majority of people had become feeling insecure in their daily lives. According to the police officers those two categories could be presented in more details. One suggestion was to design rich sub scenarios, where the personas could act. The police officers suggested that a sub scenario could better describe the information need different police officers might have. In the large scenario i.e. *Safe Svensson*, the abstraction level was too high to be descriptive enough about information need. To be able to understand future use of information systems the sub scenario should focus on use of electronic records and need for information. The police officers claimed that any scenarios should try to describe and visualize information needs, when it is information that is used and not solely electronic records.

The interviews ended with a discussion whether the police officers thought that the personas could have the same type of content if someone outside the police had made it. The question was interpreted as very hypothetical but they agreed upon that the persona most likely would be richer in details if someone with police experience were involved in the design of them.

Gained Experiences

This section is about gained experience during this research and represents a final analysis of the research and the experiment like applying of the proposed method.

The Scenario Planning and Scenarios

In this research scenario planning as method was not practiced. We have relied this research on an already existing scenario planning project. Based on literature referenced in this paper scenario planning is presented as a working method to give a picture of the future in form of scenarios. This was also strengthened after the verification of the four scenarios from Bandhold et al (2001) in the police domain.

The problem with using existing scenarios was that others have developed the scenarios and they did not cover everything this proposed method could be used

of. The proposed method aims to reduce the uncertainty and has a design focus on both electronic records and recordkeeping systems. Implicit it is therefore necessary that scenario covers information needs, and are a very rich description, which is necessary for deriving personas. A persona should be designed upon a rich material (Cooper, 2004; Grudin & Pruitt, 2002; Pruitt & Grudin, 2003), which in this proposed method must be covered by the scenarios. An alternative to present very rich scenarios is to construct sub or mini scenarios, which are rich description of every category the main scenario consists of. This was a suggestion from the police officers that verified the personas. A detailed sub or mini scenario could be the fictive context where the personas act.

For the proposed method it was necessary that the scenario planning could be proven to produce scenarios that corresponded with reality, as good as the scenario *Safe Svensson* did.

Design of Personas

In this research the personas was designed upon the scenario *Safe Svensson* in a joint effort between the two researchers. The design of personas was helped by the two different categories found in the scenario. The design of the personas was also dependent on one of the researcher that has a large experience of the police domain. The large experience of the domain could be something that compensated the lack of rich domain descriptions found in the scenario. Without the domain specific knowledge the personas had not been able to design with the level of details as they were. If this proposed method had been applied in another domain, similar knowledge of the domain and its characteristics had to be captured in some other way.

As the proposed method is meant to be a supportive tool in design of for example a new recordkeeping system, we assume that persons with knowledge of the context/domain for the planned system is involved in such project.

Future use of electronic records

To be able to identify future and unknown use of electronic records by using scenarios and personas, both scenarios and personas must be very rich described. The persona and eventual complementing sub scenario where the persona is acting should consist of an explicit need for certain types of information. If the information need is known it is also possible to derive from what kinds of electronic records that information could be retrieved, i.e. future use of electronic records. As electronic records are a subset of information it would be recommended to design sub scenarios that present characteristic work situations where the personas information need is visualized. By analyzing and understand the need for information, use of electronic records would be possible to find.

Application area

To be able to design information systems that have users that are unknown at time for creation of the system is a challenge. Unknown users results in unknown requirements. For electronic records those requirements are important to capture if an electronic record that are going to be long term preserved, also should meet future users needs. With this method proposal, we present one possible methodological tool that can aid design of information systems that are managing electronic records. For design of recordkeeping systems there exist no special design methodology, and design is managed following traditional design methods. This proposal can be seen as a method specially developed for design of the branch of information systems that we call electronic management systems.

Concluding Remarks

The research question used in this paper was: How can future and unknown use of electronic records be captured and identified? In this paper we propose that scenario planning together with personas can be a method combination that together can be used to reduce uncertainty about future use of electronic records, i.e. capture and identify the future and unknown use.

We have applied the proposed method in a public domain, the police domain, and in an experiment like way tested the method.

The conclusion from this work can be summarized as:

- Scenario planning is a method possible to use to develop a set of future scenarios.
 - Each scenario could be more rich if they are complemented by sub or mini scenarios
- The design of personas should rest on a rich knowledge of the domain where the fictive persona is supposed to act. Something possible to reach if:
 - Either one of the designer has that experience
 - Experience is gained by using more traditionally methods as e.g. interviews, observations or similar techniques
 - External participants from the domain is involved in the design process of the personas

Identification of future use of electronic records is dependent on a rich description of the persona and the scenarios. The scenarios should be complemented with sub or mini scenarios where the personas are acting in some work practice, which also should consist of details about information need. From the information need future use of electronic records could be derived. Off course an ideal situation would be to design such scenarios to include actual use of electronic records. But

electronic records are today only one of many information sources a person in an organization has available and therefore we recommend that the focus should be on information need instead on electronic records need.

Embedded in the technique of using personas, is identification of user needs and user specific requirements. In this research we have not derived and tested whether it was possible to derive user needs from the two personas. We have assumed that user needs can be derived from personas, when the technique has been tested and used by others (e.g. Cooper, 2004; Grudin & Pruitt, 2002; Pruitt & Grudin, 2003). But to further develop the proposed method this has to be evaluated as well, which is a possible task for a future research effort.

Another future research effort is to use the proposed method in another domain and perform each proposed method step fully.

References

- Antón, A. I., & Potts, C. (1998). A representational framework for scenarios of system use *Requirements Engineering*, 3(3-4), 219-241.
- Aoyama, M. (2005). *Persona-and-scenario based requirements engineering for software embedded in digital consumer products*. Paper presented at the 13th IEEE International Conference in Requirements Engineering (RE'05).
- Axelsson, L.-E. (2006). Identify user profiles in information systems with unknown users. *International Journal of Public Information Systems*, 2006(2), 19-32.
- Bandhold, H., Kairos Future, Rikspolisstyrelsen, & Riksåklagaren. (2001). *Brottsligheten och framtiden: Diskussion kring fyra scenarier*. Stockholm: Riksåklagaren : Rikspolisstyrelsen.
- Bell, J. (2000). *Introduktion till forskningsmetodik* (3., rev. uppl. ed.). Lund: Studentlitteratur.
- Borglund, E. (2005). Operational use of electronic records in police work [Electronic Version]. *Information Research* 10(4), paper 236 from <http://Informationr.net/ir/10-4/paper236.html>.
- Borglund, E. (2006). *A predictive model for attaining quality in recordkeeping*. Sundsvall: Mittuniversitetet.
- Borglund, E. A. M. (2007). RQAM: A recordkeeping quality assessment model proposal. *Submitted to journal*.
- Borglund, E. A. M., & Öberg, L.-M. (2007). How are records used by organizations? *Submitted to journal*.
- Bødker, S. (2000). Scenarios in user-centred design—setting the stage for reflection and action. *Interacting with Computers*, 13(1), 61-75.
- Carrol, J. M. (2000). Five reasons for scenario-based design. *Interacting with Computers*, 13(1), 43-60.
- Carroll, J. M. (2000). *Making use: Scenario-based design of human-computer interactions*. Cambridge, Mass.: MIT Press.

- Cooper, A. (2004). *The inmates are running the asylum : Why high-tech products drive us crazy and how to restore the sanity* (New ed.). Indianapolis, Ind.: Sams.
- Duranti, L. (2001). Concepts, principles, and methods for the management of electronic records. *The Information Society*, 17, 271-279.
- Erickson, T. (1996). Design as storytelling. *Interactions*, 3(4), 30-35.
- Eriksson, T., & Ritchey, T. (2005). *Scenario development and force requirements using morphological analysis* (No. A668834): Swedish Defence Research Agency (FOI) Division of Defence Analysis.
- Go, K., & Carrol, J. M. (2004). The blind men and the elephant: Views of scenario-based system design. *Interactions*, 11(6), 44-53.
- Grudin, J., & Pruitt, J. (2002). *Personas, participatory design and product development: An infrastructure for engagement* Paper presented at the Proceedings of Participatory Design Conference, PDC 2002, Palo Alto.
- Holgersson, S. (2001). *It-system och filtrering av verksamhetskunskap : Kvalitetsproblem vid analyser och beslutsfattande som bygger på uppgifter hämtade från polisens it-system*. Linköping: Univ., Institutionen för datavetenskap.
- Holgersson, S. (2005). *Yrke: Polis : Yrkeskunskap, motivation, it-system och andra förutsättningar för polisarbete*. Linköping: Institutionen för datavetenskap Linköpings universitet.
- International Standards Organization. (2001). *ISO 15489-1. Information and documentation and records management part 1: General*. Geneva: International Standards Organization.
- Jarke, M., Bui, X. T., & Carroll, J. M. (1998). Scenario management: An interdisciplinary approach. *Requirements Engineering*, 3(3-4), 155-173.
- Johansson, M., & Messeter, J. (2005). Presenting the user: Constructing the persona *Digital Creativity*, 16(4), 231-243.
- Kensing, F., & Blomberg, J. (1998). Participatory design: Issues and concerns. *Computer Supported Cooperative Work*, 7(3-4), 167-185.
- Lindgren, M., & Bandhold, H. (2003). *Scenario planning : The link between future and strategy*. Basingstoke, Hampshire: Palgrave Macmillan.
- Loke, L., Robertson, T., & Mansfield, T. (2005). *Moving bodies, social selves: Movement-oriented personas and scenarios*. Paper presented at the OZCHI 2005, Canberra, Australia, November 23-35.
- Myers, M. (1997). Interpretative research in information systems. In F. A. Stowell & J. Mingers (Eds.), *Information systems: An emerging discipline?* (pp. 239-266). London: McGraw-Hill.
- Myers, M. D., & Avison, D. E. (2002). *Qualitative research in information systems: A reader*. London: Sage.
- Nuldén, U., & Borglund, E. (2006). *Personas in uniform: Police officers as users of information technology*. Paper presented at the ECIS 2006, 12-14 July, Gothenburg.
- Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example, design considerations and applications. *Information & Management*, 42(1), 15-29.

- Palmius, J. (2005). *A theoretical base for the simulation of information systems : Isomorphically acted organization scenarios*. Östersund: Mittuniversitetet.
- Pruitt, J., & Grudin, J. (2003). *Personas: Practice and theory*. Paper presented at the The 2003 conference on Designing for user experiences, San Francisco, California.
- Reed, B. (2005). Records. In S. McKemmish, M. Piggott, B. Reed & F. Upward (Eds.), *Archives: Recordkeeping in society* (pp. 101-130). Wagga Wagga: Charles Sturt University, Centre for Information Studies.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- Schoemaker, P. J. H. (1995). Scenario planning: A tool for strategic thinking. *Sloan Management Review*, 36(2), 25-40.
- SHELL. (2003). *Scenarios an explorer's guide*. London: Shell International Limited.
- Smith, P. M., Allen, J. P., Stewart, J. H., & Whitehouse, F. D. (1987). *Creating strategic vision: Long-range planning for national security*. Washington, DC: National Defense University Press.
- Sundgren, B. (1995). Information systems with partially unknown purpose. In B. Dahlbom (Ed.), *The infological equation : Essays in honor of Börje Langefors* (pp. 119-134). Göteborg: Dept. of Informatics School of Economics and Commercial Law Institutionen för informatik Handelshögsk. Univ.
- Sundgren, B. (1996). We want a user-friendly and flexible system! Designing information systems with partially conflicting and unknown purposes. In M. Lundeberg & B. Sundgren (Eds.), *Advancing your business - people and information systems in concert* (pp. II: 1-22). Stockholm: EFI, Stockholm School of Economics, Sweden.
- Thomassen, T. (2001). A first introduction to archival science. *Archival Science*, 1(4), 373-385.
- Wack, P. (1985a). Scenarios: Shooting the rapids. *Harvard Business Review*, 63(6), 139-150.
- Wack, P. (1985b). Scenarios: Uncharted waters ahead. *Harvard Business Review*, 63(5), 73-89.
- Wild, R. H., Griggs, K. A., & Li, E. Y. (2005). An architecture for distributed scenario building and evaluation. *Communications of the ACM*, 48(11), 80-86.

Persona 1

Karl is 44 years old; he works at the National Criminal Investigation Department at the unit for organized smuggling of humans. He is specialized on trafficking. He is married and has 2 children 10, and 12 years old.

Background

Karl began his police career when he was 21 years old, and worked the first years as a patrolling officer in Stockholm. After 10 years he became a member of the surveillance team at the narcotic department. He worked both with investigations and surveillance for almost 8 years. When the National Criminal Investigation Department started the new department for smuggling of humans, he applied for a position as investigator. During his years at the narcotic department he have gained knowledge about how organized crime used vulnerable persons to smuggle narcotics. At some occasions Karl and his colleagues saw that criminal elements both dealt with narcotic and prostitution. It seemed to be more of a coincidence which person that became a victim for trafficking or smuggling of narcotics.

Present

The last two years have been successful from a police perspective. The large collaboration between the European countries and their police, especially the countries that have signed the Schengen agreement have made police work more efficient. Europol and Interpol are two organizations that have given police forces in Europe tools for better collaboration. After the terrorist attacks 9/11 2001, Karl have noticed that there have been easier to get information from other police authorities in other countries. He believes that there is a common understanding that organized crime is one important money contributor to terrorists.

On daily basis Karl is using the possibilities this new police collaboration offers on daily basis. He searches for information in information systems that are available as a result from this police collaboration on almost daily basis. Earlier when Swedish police not had this open access to information from other countries, such information was used any way. But the information was received using informal channels, and was not possible to use as evidence in an investigation.

Karl just recently closed a case where several girls were illegal brought to Sweden to work at an illegal brothel. During the raid against the brothel the police only could arrest a few persons involved in the trafficking, and smuggling of young girls from former Soviet Union. But by using the IT systems available Karl could track how the girls had entered the European Union, and also verify that they have been here at two separate occasions. IT systems supporting the Schengen agreement helped Karl to receive information which persons that crossed the

border to the European Union at the same time as the girls did. This gave names on suspected persons, which was an input for further investigations and after more than one year ten persons was arrested in Slovenia and transferred to Sweden for court proceedings. Six of the arrested persons were judged and convicted based on their involvement in trafficking and prostitution.

Persona 2

Johanna is 39 years old, and has worked as a community police since 1993 when the community police reform was introduced in Sweden. She lives together with John 38 and their two children 8 and 12 years old.

History

Johanna began her police career as a patrolling police officer in central Gothenburg in 1989. She felt unsatisfied when she always was called out on a job after something had happened. It was like being a cleaning unit to clean up the mess someone has done. When the community police reform was introduced she moved back to her hometown and began as a community police officer.

Present

Today Johanna is working in a larger project, safe downtown (Tryggt centrum). The Swedish National Council for Crime Prevention's local office (Lokala Brottsförebyggande rådet, Local BRÅ) has been initiated the project. Local BRÅ have made a large citizen survey. The result showed that the majority of the citizens didn't felt secure when they were down town. The citizens felt insecure both during day and night.

Johanna has been the local police authority's contact person in the project. She has worked real hard to argue for the projects idea and suggestion to put up surveillance cameras on strategic locations in the city. The project has got permission for 8 cameras from the County Administrative Board. Johanna think surveillance gives so many positive effects that the intrusion in to the personal integrity can be motivated.

The last two years Johanna have started to be interested in Internet surveillance. Internet is a both a new area for criminality, but also a place where criminals boast about their activities. For example, during the last two months there have been three situations where people have been assaulted un-provocative during weekends by a gang. The gang has recorded their assault by using telephones and later on they uploaded the film on sites similar to You Tube. Unfortunately does the police authority not have some police with qualifications to deal with electronic evidence. Johanna is also critical against the police IT systems that have no possibility to manage for example movies, and sound. Today a film as presented above is burned on a CD and added to the investigation. There are no

possibilities for other colleagues to search and retrieve that piece of evidence. The result is that each case file is not searchable and retrievable for other colleagues.

Johanna and local BRÅ is also working with crime statistics. Unfortunately do the police IT system not give here a possibility to retrieve data from the systems that can be used in statistical analysis. The data they need must almost manually be retrieved.

A Reflective Perspective on Researcher Involvement in Software Development

Carina Hallqvist
Växjö University
Sweden
carina.hallqvist@vxu.se

Abstract. The objective of this paper is to discuss a possible dilemma that researchers can experience participating in development processes as both member of a studied society and as a researcher. There are methodological and ethical issues involved, opening up for challenging questions. Some of these topics were researched in a project where ad-hoc or 'intuitive methods' formed a platform for reflection. Aforementioned project, presented in this article, delivered several concepts for a communication platform. The result was not specifically innovative per se. A far more interesting result was the lessons learned and the knowledge about new methods and roles of participation that was gained during the process.

Keywords. Action research, participatory design, interaction design, user involvement, researcher involvement

Introduction

During the past few years the border between being a user/consumer and being the developer/producer has started to dissolve. Examples from open source projects and social movements point out that the user positions are moving from being a user or consumer towards also being the developer or producer. As the positions are moving and the roles are merging, people can become more and more involved in all parts of the development process. This can be observed both for system development as well as design processes. The same holds for the roles and interventions that scientist should or could have in the development

processes. Action researcher and action research theories (Avison et al., 1999) combine theory and practice, and researchers and practitioners. In earlier work researchers have participated closely together with practitioners. But what happens when the academic researcher also is a part of the society or group that is studied i.e. when the researcher at the same time is a practitioner and member of the subjects of research? These questions have been a well-known topic among ethnographer. In ethnographic studies the ethnographer's task was to become an accepted member of the group, including participating in its cultural life and practice. Critics have pointed out that there is a risk that the researcher could get over-involved, perhaps disturbing and changing the natural setting or moving from the role of researcher to that of advocate (Robson, 2002, pp. 186-190). The disadvantages of being a member of the studied society are in this article taken into consideration. However an advantage could be that we gain a deeper understanding from within versus looking from the outside as we participate both as researcher and user (Dittrich, 2002). Having an inside perspective can contribute to understanding (Rönnkö et al., 2002).

Applying social science methods in software engineering research opens up questions on influence of the researcher and the findings on the research subject(s) as methodological problems on the one hand as it on the other hand is subject to ethical discussions (Dittrich, 2002). One challenge could be to discuss how we participate as an academic researcher in this social group's activity. We may need to develop methods and understanding of the underlying factors that both can be regarded as obstacles as well as it simultaneously add knowledge as we participate. Rönnkö et al. (2002) argues that "applying an ethnographic perspective opens up an inside perspective on methods and their applicability that might as well reveal problematic aspects".

In a research project, described below in section three, 'intuitive methods' were tried out, implemented and studied. In the project users also became the system developers. The academic researcher participated both as a researcher, developer and as a member of the user community. It is of interest to discuss how the researcher could have multiple roles in such a development process. The project resulted in the development of several concepts for a communication platform. The result was not specifically innovative per se. A far more interesting result was the lessons learned and the knowledge about *new methods* and *roles of participation* that was gained during the process.

On a practical level the key issues are, however, almost always a matter of how we combine theory and practice when the researcher and the practitioner is one and the same person. These key issues lead us to discuss the roles and attitudes of participation. It may be fruitful to take this discussion further with the following question: How can we combine theory and practice when the researcher also is one of the practitioners? Methods need to be investigated and developed to support these processes where the user takes an extremely active part through the

whole process. Theories from the field of Action research were used to assess ‘the degree of participation’.

The argument is presented as follows. Section 2 presents the theoretical framework including action research, participatory design and interaction design. In section 3 the empirical setting is presented. The case is used for describing methodological issues and as an example for the discussion on the theoretical topics. In the discussion in section 4, we link the project findings to our theoretical framework presented in earlier section. Finally, in section 5 the conclusion summarize the findings and outlines future research.

Theoretical Framework – the Reflective Perspective

The author use action research theories in the context to discuss positions for practitioners and researcher and the building of research based knowledge. Moreover, for the discussion on participation and roles for participants in the design process Participatory Design theory is used. Finally, Interaction design theory is described and used as a base to compare the aforementioned theories. It connects the discussion on roles and position together with the discussion on how knowledge and experience is created and transferred back during the development process, thus using flexible design.

In Social science the researcher is allowed to become a part of what is regarded as the researched object. Most scientists have strived towards an objective view. But, intervention and other influence have become more common. In action research, methods used by practitioners, are studied through close participation of both practitioners and researchers. Feedback from practice has always had high esteem in software engineering research (Dittrich, 2002). Action research is a qualitative research method that is unique in the way it associates research and practice, so research informs practice and practice informs research synergistically (Avison et al., 1999). Avison et al. (1999) argues that in action research the researcher can experiment through intervention and to reflect on the effects of that. In action research, the researcher tries out a theory together with practitioners in real situations, gaining feedback from this experience, modify the theory as a result of this feedback, and trying it again. Each iteration of the action research process adds to the theory (Avison et al., 1999).

Further discussions on how knowledge can be transferred back to development processes, is taken by Nunamaker et al. (1991) and later by Mathiassen (1998). Nunamaker et al. (1991) proposes a research framework on how knowledge can be transferred back to the research methodologies and to the research domain during the development process. Nunamaker et al. (1991) suggest that this concept with wide-ranging applicability will go through a research life cycle of

the form: concept - development – impact. The role of the system development in their scheme

“... is the result of the fact that the developed system serves both a proof-of-concept for the fundamental research and provides an artifact that becomes the focus of expanded and continuing research” (Nunamaker et al., 1991, p. 92)

i.e. system development as a research method.

In the article *Reflective Systems Development* Mathiassen (1998) adapt this approach to systems development research. He distinguishes three types of approaches: Action research, Experiments, and Practice studies. Mathiassen says that all three approaches, often in combination, contribute to the building of research-based knowledge in the form of theories and methods (Mathiassen, 1998, p. 73) and that Practice-related research on systems development is based on one, or a combination of these three approaches (Mathiassen, 1998, p. 74). Mathiassen is influenced by Donald Schön's (Schön, 1983) ideas on how professionals think in action (Mathiassen, 1998, p. 68).

Participatory Design (PD) can be explained as an activity that takes place in a participatory context. The roots of PD can be traced to the work of the Scandinavian unions in the 1960s and 1970s. Its ancestry also includes Action research and Sociotechnical Design¹. The concept *collective design* appeared in the early 90s to separate and characterize another dimension of PD (Granath 1991, 1993). The method development in this period was focused on the initial stages of the design process (the programming). Advanced methods (programs and schemas) for data collection and systemizing were developed. Employees (users) were often represented by experts during this period. A good expert was regarded as the best representative to listen to everyone involved, and with this information produce solutions that were acceptable for all participants. With a more global market and the use of sophisticated production technology, a larger engagement from the rest of the organization was needed. This need put new demands on user (worker) *participation* and new methods were sought. An early example of a collective design process of a complete manufacturing system is the design of the Volvo plant in Uddevalla (Ellegård 1991, Granath 1991, 1993). The new dimension of the processes was that the users were the experts.

Donald Schön (1983) gave some other important concepts. He discussed the term *reflection in action*. The reflection occurs, Schön (1983) says through communication which consists of three different types of dialogue: an inner dialogue, an inter personnel dialogue between the participants, and the dialogue that occurs through the design of the design object. In collective design, the inner dialogue can be visualized through the design activities where the design model or the object is manipulated and reshaped. The participants also build a collection of solutions and examples, which becomes a part of their common praxis (Schön, 1983).

¹ From the web page <http://cpsr.org/issues/pd/> accessed 22 jan 2007

When a researcher participates in a collective design process this can be seen as *interactive action research*. Hultman and Klasson (1994) have proposed a model where the participants, researchers, and the company create knowledge and experience when they perform studies in a changing process. This model has several similarities with a collective design approach and research on the design process.

An important part in a design or development process is the meaning of the knowledge and competence that the participants bring with them. Here the role that the designer has in the design process² is discussed, based on theories from Löwgren and Stolterman. “They contribute with »practical design theory» and connects to a design tradition that is associated with Donald Schön and his idea of *the reflective practitioner*” (Löwgren & Stolterman, 2004)³.

Löwgren and Stolterman argue that the work with digital artifacts have a character that demand a new perspective on design – a *reflective* perspective (Löwgren & Stolterman, 2004). They discuss further that the result of a design is not always dependent of a design decision but rather depends on unexpected or unwanted side effects. This could be regarded as negatively if the result does not work in the situation it was intended for. Löwgren and Stolterman (2004) suspect that the design in this case can suffer from a kind of lack of knowledge or limitations. This can lead to that the digital artifact is experienced as being imperfect. Design is a complex task, it is always unique and not a process that can be prescribed or described (Löwgren & Stolterman, 2004). The authors mean that normative efforts never can be sufficient. On the contrary a reflective attitude is called for. When investigating your own role as designer, using critical thinking refers to reflection. You are more observant vis-à-vis your own design skills and the result that you produce. To use existing theories and models demands a critical attitude (Löwgren & Stolterman, 2004). They argue that it is both necessary and fruitful to look upon this development as a design discipline. They also point out that the fundamental issue is what kind of knowledge the designer needs. Furthermore, they draw up the field of knowledge *interaction design*. These theories can be seen as applicable also when roles are not clearly defined. The arguments are used to support our discussion on – *different roles of the researcher*. What different background or experience (pre-understanding) the researcher has can also be said to form the different role that s/he can have in a development process.

² Löwgren and Stolterman refer to design processes as also including design of information technology. The development of digital artifacts is a design work

³ Preface »Den reflekterande interaktionsdesignern» av Ehn P. till boken *Design av informationsteknik* (Löwgren och Stolterman, 2004)

Research approach

In relation to the theoretical platform discussed above we in addition adopt, in the case described in the following section, some of the concepts of *flexible design* taken from Robson (2002). Robson (2002, p. 165) discuss that theory doesn't need to be there from the beginning but can evolve. He argues that you should start with some early decisions about methods of data collection in order to get started, but:

'... you don't have to foreclose on options about methods. Ideas for changing your approach may arise from your involvement and early data collection. Or, as you change or clarify the research questions, different means of data collection may be called for. Similarly, your sampling of who, where and what does not have to be decided in advance. Again you need to start somewhere, but the sampling strategy can and should evolve with other aspects of the design.' (Robson, 2002, pp. 165-167).

This article will only discuss the topics on researcher involvement and use the case findings for this. The result of, and methods used in the project have been counted for in earlier, referred to, articles.

The case

The case, *the [miki-wiki] project* used Robsons (2002) proposal of flexible design as theoretical position. Moreover the project gives an example on how new attitudes from the users of 'technology of tomorrow' demand to take an active part in the creation and development process. Methods from the Participatory design and interaction design area were used as a base for communication and participation within the project team i.e. roles and participation concerning both producer/consumer and practitioner/researcher and on reflection in 'doing practice'. The purpose of the project was mainly to investigate how methods where used and developed during a flexible design process. One aim was to transfer knowledge, through the project result, back to the research methodologies and to the research domain during the development process (Nunamaker et al., 1991; Mathiassen, 1998). By close participation and reflection methods used in the project was investigated in a 'reflective systems development' process (Mathiassen, 1998).

Background and setting

Interactive Institute studio [12-21], University of Växjö and a national federation for youth, Tech Group⁴, collaborated in the *[miki-wiki] project*⁵ (Hallqvist, 2004a). The project aim was to investigate how cell phones and mobile equipment could be used in a day-to-day communication for collaboration in

⁴ Tech Group is now called Booster. www.boosta.se, last visited 2007-03-26

⁵ The project started in November 2003 and ended in June 2004.

distributed work scenarios, a context that was common and well known by all participants in the project. The project later generated sixteen concept, prototypes or solutions (Hallqvist, 2004a, 2004b).

The name of the project originated from the 'Wiki concept' where users collaborate in forming content. People from each organization participated in the project as both users and developers. The project manager was a Ph.D. student at the University of Växjö, associated with the studio [12-21]. The manager role implied participation both as researcher, developer and as user. One representative from the Tech Group organization participated in addition both as a user and assisting project manager. These two persons had the formal administrative responsibility towards the rest of the project team. The project organization was extremely 'flat'. All decisions were made in agreement with the rest of the team. The administrative hierarchy was mainly for practical reasons towards the financier and to reassure that documentation was done and stored properly.

Method

The *Funnel method* used in interaction design was chosen as a basic concept for method in the project. According to this approach the development process start with a wide conceptual overview i.e. 'design principles', then narrowing down in a 'function design' that ends in a 'detailed design'. This approach had been used by the studio [12-21] in earlier projects with good result and knowledge about possible techniques that could be useful when the surrounding context is important.

Purpose

The need for useful tools was a goal that united all participants. One aim was to come up with new and innovative solutions that could support collaboration in geographically distributed work scenarios. There were no detailed decisions beforehand on what or how this was going to be done.

Implementation

The work started out with meetings and workshops where the participants initially learned to know each other by finding out similarities and differences in their respective groups. Through brainstorming, along with a combination of methods, the team sorted out several ideas into a common structure. This phase took a lot of the project's initial time as ideas and structures had to mature. The result of this conceptual design phase could be sorted into five separate 'areas of interest' which all included several interesting solutions. A direct result of the first conceptual phase gave that these five areas were too large to be brought to the next phase. However there was no shortage of people as a resource therefore the

team decided to try to continue the development process although the organization had to re-group.

The original design model and methods became instead duplicated as the five areas became divided into five different *subprojects*. In addition the project team was divided into five. Thus the original funnel model was divided into five separate funnels. At this stage the project team consisted of five different subproject managers in addition to the original two and had as a result become as distributed in the organizations as they were geographically. Moreover more users were involved in each of these subprojects.

Each subproject team planned their time and processes themselves, with support from the project managers. Additionally weekly meetings were needed where the original team met and coordinated their means and efforts. A wide range of methods was used to support and ensure documenting each subproject. Most of the users were under the age of 25 and already familiar with digital media from the beginning why this often was chosen for documentation. Subprojects recorded meetings on Mp3-players or on video etc. All meetings had additionally one member doing nothing else but taking notes. These 'minutes' were later transcribed and posted on the web. Taking minutes and transcribing was regarded easy due to the assistance of the recordings. Also, pictures were taken of white boards and storyboards during the process. This second phase resulted in more detailed descriptions and development of 14 concepts that the sub-teams wanted to implement further.

During the third design phase the building of mock-ups or prototypes allowed several ideas to be tested. These designs were taken into a more detailed level in accordance with the initial method, the funnel. At this stage, the project organization was re-structured once again. The five subprojects were divided into several production teams led by their former subproject manager. This resulted in that all ideas were taken through the detailed design and some of the concepts were later developed and tested. As the project lasted for a very short time and that time was used mainly for design and development, there was practically no time left for deeper analysis during this period. Therefore the result and the process had to be, and so were, carefully documented. The analysis was later conducted by using a combination of qualitative and quantitative methods, which resulted in a design- or system specification. This analysis and its result is described by Hallqvist (2004a, 2004b) and will not be included in this article.

Although the project time had ended, the subprojects and their production teams continued to develop their ideas. However, before this continued, an analysis was made which resulted in a specification matrix. The matrix identified common variables for the concepts that could be used to develop a common platform as a basic toolbox for further development. This supported the subprojects in not having to 'reinventing the wheel'.

Participating in an experimental development processes both as a researcher and as a practitioner established yet another role for the researcher involved. She found herself in the twilight zoon between observation and participation. How can this be handled, and how can s/he identify the roles that s/he might have. Another question would be what methods are actually used beside the intended? The section below discusses some findings from the project concerning these topics and relates the to the theoretical framework described in section 2.

Discussion

The project team members came from three different areas with a lot in common but also some very easily defined differences, for instance age and experience. Each group entered the project with their own 'pre-understanding' of the common context. Very soon this grew into a mutual frame of reference. To illustrate the team members' ambition to reach a common praxis (Schön, 1983) for communication and understanding a concept will be presented: *scouting*. A scouting could be to report anything of interest that the participants had found in journals, on Television etc. All project meetings started with a scouting report on interesting issues that had come up since the last meeting. This was a well-regarded element that began all meetings and gave the participants a wider perspective and knowledge of the respective group. This can also serve as an example of the flexible design (Robson, 2002) that was used in the project. When participants felt that they were lacking knowledge on the other team members introducing scouting as an additional tool solved this.

By reflection in action (Schön, 1983) and transferring knowledge back to the development process (Nunamaker et al., 1991; Mathiassen, 1998) the project team used their theoretical approach when adding on methods or tools as support to new insights and demands. One example was given above and another one is given here. As the project organization was flat and the control was moved out into the subprojects group some discussions were raised on the risk for the project management in 'loosing control' over the project. Good reporting and possibilities for all parties to participate in all meetings solved this. Instead of turning this issue into a risk, the project management looked at it as a possibility and used it as an experiment on how loose 'control' the project management could have. The project management could of course at any time stop this evolution and to bring back control if needed. This was never done and the experience from the creativity in using methods and tools in order to let everyone take part in what happened was far more valuable than having total control of all courses of events. This flexible design and not having to foreclose on options about methods but letting them evolve was inspired by Robson (2002) and supported by theories from Schön (1983), Nunamaker et al. (1991), and Mathiassen (1998).

One easily defined problem for the management was a constant lack of time. As the process and the development moved further out in the organization more and more people got involved. The process could go on 24 hour a day and not only from '9 to 5'. This made it impossible to participate all the time, but was never regarded as crucial. But, being also one of the participants some of these issues were solved. Having the role both as user participant and researcher had many advantages in understanding from within (Dittrich, 2002) but it also gave little time to academic writing. Moreover, participation in research project takes time in writing project reports instead of academic articles. There are project deadlines to meet and reports to be made, and endless meetings. A lot of problems need to be solved regarding this for the future. Traditional demands on publishing are still there as in the same time a lot of research project becomes increasingly global, and by this more like traditional development processes. The fact remains; there is still little time for reflection and academic writing.

To conclude, documentation was fundamental in this process. It made the follow up easy and ensured communication through all levels of the organization. Without it there could never have been any analysis of the outcome of the project as this wasn't included in the project timeline. Possibly good documentation was also one of the most important factors that made the project management or the team members never experience losing control over the processes. Also, in later building the specification matrix additionally ensured that redundancy in many of the concepts was identified and handled. Furthermore, the matrix gave a cross concept overview of each component. The development teams that later continued to develop some of the concepts after the project had ended could use this matrix. It saved both time and money, and showed to be efficient in avoiding developing the same solution twice. Having the result of the project and using this knowledge for further analysis can also be regarded as a part of the flexible design (Robson, 2002).

The insider perspective

In the [miki-wiki] project the researcher had the role of both taking an insider and an outsider perspective this also saved time for the team in not having to explain all actions made. Dittrich (2002) calls this understanding from within and looking from the outside. It can be important to document the researchers '*pre-understanding*' in order to understand the result of her/his research. In Hermeneutics it has been discussed that our understanding is closely linked to our '*pre-understanding*'. For example in order to properly understand a book one has to get into the context of the author and the epoch, and environment the book was written in. Our '*pre-understanding*' can however grow during time. Being both a practitioner and a researcher or a consumer and a producer may give us a good perspective of the researched context i.e. a good '*pre-understanding*'. That is

when s/he participates in activities that affect the context, and at the same time tries to interpret or describe them. The researcher carries this experience and the context with her/him. Moreover, choice of methods and interpretation could be influenced by her/his earlier experience.

Ethnography focuses on practices from within. Researchers in this area often use observation as method. As it can be difficult to observe while participating additional methods or tools has to be applied. In this article all possible methods haven't been discussed but an argument will be made that a combination of methods is often needed. Recent project I have been involved with have often used both quantitative and qualitative methods to ensure validity. An illustration to this in the case above was the specification Matrix. Triangulation could also be regarded as necessary when the participants have multiple roles in the development process. It might also be of importance to achieve good knowledge about roles that the participants can have. Dittrich (2002) gives three important issues to be considered when going into empirical research: Whose perspective do we adopt when designing our case studies? How do we relate to those we study? How do we formulate our proposal for change? This kind of issues that in other context are regarded as ethical questions becomes methodological issues (Dittrich, 2002). Traditional ethnographic studies often take place for a long period of time in order to collect data and develop an intimate understanding of the group. Rönkkö et al. (2002) suggests the cooperative method development approach to provide a 'inside view' provided by ethnographic studies. The 'pre-understanding' of the context that a software engineering researcher might have can never be less than the one an ethnographer in a foreign culture has (Rönkkö et al., 2002). In the [miki-wiki] project the researcher had this advantage because of her background as a software engineer. One advantage was the time saved on not having to learn everything from the beginning. One disadvantage could be that some ideas never were regarded due to pre-assumptions.

Intuitive methods

By transferring knowledge back to the research process and letting results contribute to the body of knowledge (Nunamaker et al. 1990) we can create new methods or further develop good methods that can be more suitable for the community of practice and research. The [miki-wiki] project had learnt that the users were using some methods intuitively without knowing that they actually were using them, and then sometimes refining it for the next time used. This theory was tested in the project setting with ethnographically inspired methods as an exploratory practice study. We, the researchers, wanted to explore and learn more about alternative methods in system development and the design process, based on the experience from earlier projects within the research group and from experience of participation in different communities. One problem discovered

concerned how to interpret cognitive praxis. In order to ensure validity multiple methods of data collection was used. Interviews, taking minutes, and recordings (both Mp3 and Video) were used to ensure that nothing was missed while participating in the process. These methods were never formally discussed or decided on during the project planning. Each situation that occurred gave its own solution. However, this scenario does not give a global solution on how this best is done. It only gives an example on how it was done in the specified context where users felt comfortable with using digital media.

When subproject teams worked together in the subprojects they used well-known methods like brainstorming and workshops for inspiration with a lot of influence from the participants. There was, however, no workshop done in the same way. New ideas were constantly tested. Furthermore, when new issues came up one of the groups instantly took care of the situation. For instance there could be a need to gain more knowledge about an area by scouting or finding someone in the organization that had the competence that was needed. The project members worked with problem solving by admitting that there was a lack of competence and then finding a solution for it. This awareness made the project an on going process that never rested, almost like a relay race.

When people act and perform in the same context and add to the collective knowledge they do this because 'it makes sense'. The people are very much part of their own environment (Weick 1995). Weick means that sense-making is to talk about reality as an ongoing accomplishment that takes form when people make retrospective sense of the situations in which they find themselves and their creations (Weick 1995, p. 15). The concept of sense-making has in the project become the deeper level of understanding taken from ethnography. All methods and tools that were used in the [miki-wiki] project and all participation were made because it made sense to the project team and their organizations.

Conclusion

One difference between the project discussed above and many other cases reported in the literature was that the researcher did not only take action as a 'researcher in close participation with the practitioners' but also took action as a participant i.e. being a part of practice in designing things.

As discussed above a cooperative design process puts focus on integration and interaction. But cooperation does not occur by itself. A lot of effort is needed to create a mutual understanding and respect. In the initial phase of a development process much effort needs to be put into this. The time taken to achieve dialogue can later be transferred back to the process as a valuable asset that could ensure validity and usability.

Another difference was that the purpose with the [miki-wiki] project was for the researcher not only to study the 'culture' as an ethnographer but also to take

part in a development process as a member of a studied context, and simultaneously documenting and analyzing. A question to pose could be: can or should we as academic researchers, by going from a more objective epistemology view towards a more participate view as in social science, through participation, intervene? This is an ethical question and should be taken into consideration before a design process is started. Earlier ethical considerations in order to avoid influence from the researcher could need reevaluation. Methods documenting the researcher influence might be used rather than methods to avoid influence.

My future research will discuss and address questions concerning: when an academic researcher is being a 'part of practice in designing things'. Focus will be on how methods can evolve and be developed in settings where the researcher act and intervene as 'a probe'.

References

- Avison, D., Lau, F., Myers, M., Nielsen, P. A. (1999). "Action Research. To make academic research relevant, researchers should try out their theories with practitioners in real situations and real organisations", *Communications of the ACM* 1999, 42, pp. 94-97.
- Dahlbom, B., Mathiassen, L. (1993). *Computers in Context: the philosophy and practice of systems design*. Blackwell, Cambridge, MA & Oxford, UK.
- Dittrich, Y. (2003). "Doing Epirical Research on Software Development: Finding a Path between Understanding, Intervention, and Method Development". In: Dittrich, Y., Floyd, C., Klischewski, R. (eds.): *Social Thinking – Software Practice*. MIT-Press 2002, pp. 243-262.
- Ellegård, K., Engström, T. & L. Nilsson. (1991). *Reforming Industrial Work: Principles and reality, In the planning of Volvo's car assembly plant in Uddevalla*. Arbetsmiljöfonden, Stockholm.
- Eyerman, R., Jamison, A. (2005). *Sociala rörelser I en ny tid*. Studentlitteratur, Lund.
- Granath, J. Å. (1991). *Architecture, Technology and Human Factors: Design in a Socio-Technical Context*. Ph.D. Diss. Göteborg: Industrial Architecture and Planning, Chalmers University of Technology.
- Granath, J. Å. (1993). "Learning through Collective Design and Reflection", Paper for *the International Conference on Theories and Methods of Design*, May 1992. Proceedings, ed. Kazemian, R. A. pp227-236. Göteborg: Chalmers University of Technology & Royal Institute of Technology.
- Hallqvist C. (2004a). "Young participant driven design of digital services", In proceedings of *IRIS27*, Falkenberg, Sweden
- Hallqvist C. (2004b). *[miki-wiki] - Slutrapport*. Project report. Studio[12-21] Interactive Institute, Växjö, Sweden
- Hellesnes J. (1989). *Hermeneutik och kultur – Filosofiska fragment*. Daidalos AB, Göteborg.
- Hultman, G. & A. Klasson. (1994). *Learning from change? A note on interactive action research*. Paper presented at the Conference on Learning and Research in Working Life, June 20-23, 1994, Lund, Sweden.

- Löwgren J. Stolterman E. (2004). *Design av informationsteknik - materialet utan egenskaper*. (Second Ed.). Studentlitteratur, Lund.
- Mathiassen, L. (1998). "Reflective Systems Development", *Scandinavian Journal of Information Systems*, 10(1&2), 67-118
- Nunamaker, J., Chen, M., and Purdin, T. (1991). "System Development in Information Systems Research", *Journal of Management Information Systems*, 7:3, pp. 89 – 106.
- Porter, D., Diani, M. (2006). *Social movements – An introduction*. (Second Ed.). Oxford. Blackwell Publishing, p 20ff
- Robson, C. (2002). *Real World Research*. Blackwell Publishing.
- Rönkkö, K., Dittrich, Y., and Lindeberg, O. (2002). "'Bad Practice' or 'Bad Methods' – Are Software Engineering and Ethno-graphic Discourses Incompatible?" *Proceedings 1st International Symposium on Empirical Software Engineering (ISESE'02)*, Nara, Japan, (204-210).
- Schön, D.A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic books, New York.
- Weik, K. (1995). *Sensemaking in Organizations*. Sage Publications, Thousand Oaks, CA.

Participative Process Modeling as A Training Wheel

Kaisu Juntunen

University of Oulu, Department of Information Processing Science, Finland
kaisu.juntunen@oulu.fi

Abstract. In a social- and healthcare sector, an interesting phenomenon is that despite numerous ICT projects accomplished only a few of them have produced prevailing ways of acting in the service produce. This article depicts a Case, based on action research, how a process modeling has been used as training and motivating wheel for personnel in a new Technology Health Center in Finland. The presumption of the study is that an early and concrete participation of employees can lead both process improvements and work satisfaction. Also it is an example of that how attitudes can change and help managers make strategic plans together with the persons who owns except the skills, the valuable tacit knowledge. A lot of articles have been written about participative design (PD), but in this case, the employees really model the workflows by themselves, with the help of the

Juntunen, Participative Process Modeling as A Training Wheel

ICT motivators. This multidimensional approach loads new technical elements and tools to PD, making it stronger IS design method. The paper represents “work-in-progress” and is part of the larger CreaProc -research project, which aims at collecting and analyzing the best practices of ICT enabled public and private work processes.

Keywords. Participative process modeling, Business process redesign, Motivation, Process improvements, Organizational process change, Socio-technical systems design, Quality, ETHICS – method, Action research, Design science.

1. Introduction

Finland, as the other Nordic countries, is aging quickly. Also the unexpected global change powers expose large pressures to our welfare state. The relevant question is: how long are the so called ”big age groups” able to produce those welfare services needed to our society? To cope with those demands by means of the still decreased resources, it is obvious that new methods and tools are needed, for both social- and healthcare sector. Related to those ideas and resources, Martikainen et al., (2005) refer to the original thinking of Joseph Schumpeter (1911): Innovations are new ways of utilizing resources. If we connect this idea to Järvinen’s (2007a) classification of design science result as a goal function, we can see an interactive learning process between participating actors associated with the new artefact or innovation. The key question is, how do we manage to dig out and present those learning results and connect them to those strategic goals of organizations. In this kind of information management we now refer to David & Foray (2003), who propose that *knowledge codification* (codification = to arrange facts, laws etc. in a system, Longman Dictionary, 1995) may, in the future, have significant financial impacts in information management.

Over the past decade, the public organizations and services have also faced unprecedented change: they are expected to be productive and profitable, and capable to use multiple sources of information and different kind of technology to guide their work, and service their increasing amount of customers. To understand all benefits or disadvantages of information systems today, we have to understand

not just a business strategy of an organization in question, but also its structure, culture, domain, power- and responsibility relationship, etc.

According to the studies, the estimations of enterprises' information quality errors vary from 0.5 – 30 per cent. Except ethical and social problems, these errors also cause both economic and communication problems (Laudon & Laudon, 2002). Besides information systems, *the way the organizations act*, can also turn out a bottleneck.

An idea to utilize ICT -technology has very often started from a suggestion of an administration or an ICT producer, and it has been waited to solve many problems of the service production. Emphasis in these utilizing projects has, after all, been to introduce and develop technology. Systematic service processes developing and *action models planning* have remained less known and the social effects of technology have often appeared not until several years delay (Hyppönen, 2004). One of the interests of this study is to make technology users' voice heard in this multi-faceted, simultaneous, complex and discontinuous change process. The other is a belief that improving work processes is a same as improving a work satisfaction. Because of this socio-technical point of view, the classical ETHICS method was chosen as a one way to work with the staff.

This report deals with an interesting experiment: what will happen when a staff wants to learn how to depict and model their own work processes? Rather a peculiar idea, most of us may think first, but imagine this scenario: Hospital board members want to cut the district staff substitute budget and close some wards in the summer. At the same time there is a big reengineering project going on to reconstruct the information systems and the money is reallocated for that project. They justify this decision on the lack of evidence that a staff development may produce any savings henceforth or in the future. Instead of that, they are offering a declining budget and pressure to improve results. Now, another scenario: The board increases the staff training budget. They do take a risk, but they want to test a *change* as a possibility to enlarge the staff competence, and at the same, utilize an important organization component: tacit knowledge. Which scenario will you choose?

2. Background and goals of the study

In the year 2006, I was teaching and studying process modeling at the University of Oulu. I made some observations and interviews in different healthcare

organizations, in order to record and later model and analyze the work processes and then try to suggest some process improvement for possible bottlenecks (f.i. identify waste in the value stream).

I was really surprised how inventive those workers were, to copy with all unexpected problems in their daily situations. I also noticed how eager they were to tell about their work and how interested they were to hear about the results of my study. I began to think, how challenging it would be, to get workers depict their own tasks and workflows. A chance for that arose, when I met the project manager from a new technology health center. Their idea was to produce e-services to the customers of a certain district and for that they wanted to use self organized teams, consisted of doctors and nurses. Because they now got an opportunity to start from a “clean” table, they were eager to use their team abilities and personal competence to create something new, something of their very own. Also they were willing to learn a new way of thinking and extend their professional skills. Naturally, the stakeholders of the Health center had their own goals; with the new work processes and know-how of the staff, they wanted to utilize new ICT solutions in a customer-oriented further development of their service production.

In the next chapter, we aim to develop a holistic framework for the development and use of the participative process modeling to see this phenomenon as a social construction. The framework comprises organizational culture, structures, open, social systems and power relationships.

3. A Creative Person or Intellectual Machinery - Theoretical Underpinnings

3.1 The situation factors and “nourishing” flows

If we want to examine the organization more closely and find its “nourishing” data flows, we have to penetrate ourselves into its deep structures. To be able to orientate, we need a good map and several tools. According Mintzberg (1983), enterprises should notice those internal data flows and they have to define the internal relationships of the different parts of it. In order to an efficient structure,

Juntunen, Participative Process Modeling as A Training Wheel

the nine designing parameters, “tools” have to be internal identical. These are *specialization of work, formalization of behaviour, education and orientation, grouping to units, size of the unit, designing- and control mechanics, equipment and vertical and horizontal decentralization.*

The situation factors associate with those designing parameters are for instance an age and a size of the organization, technology in used, environment (stable, dynamic, complex), threats (e.g. competitors) and power relations. According Mintzberg’s configuration hypothesis, it is possible to affect on organizations’ efficiency by considering the internal connections between designing parameters and the situation factors. In our case, the Health Center was entirely new, technically equipped, serving 10 000 inhabitants with about 40 workers, who had been chosen according their willingness concerning team work and the technical skills they had. A remarkable thing was that even the work methods and the skills of the workers were standardized and the core jobs were looked after by operative staff, this organization did not want to act hierarchically way, as hospitals usually do, otherwise, it wanted to have an open interaction between workers and its customers, too.

3.2 Social and technical aspects in open systems

According Von Bertalanffy, in open, social systems as organizations, attention is paid to human behavior and intercourse inside the system, between its borderlines and those demands, presumed by a use of the different systems. By investigating a whole or a part of an organization through an open system we can better understand the connections between technical and social aspects as an individual/a group, an individual/an organization and an organization/an environment. Stacey (1993) presents that in *open system* theory, technical systems are as significant as social systems and hence they should not be treated separately but, in inspection, one should see their bilateral dependency on each other. We can see this kind of thinking in our case, too.

3.3 Roles, norms and values

A behavioristic school sees people highly motivated to take part in decision making concerning their own work methods and technology in used. Problem solving methods like Soft Systems Methodology (SSM) see a social system as continually changing interaction by three elements: *roles, norms* and *values*.

Juntunen, Participative Process Modeling as A Training Wheel

Because a system is always, in a certain way political, there can be also seen an interaction of interests, power relations and management of activities of players. (Checkland & Scholes, 1990). We also noticed that when we built those groups, some people were more active, even domineering others, and there was some tension in the air, too. In this kind of situations, we tried to confirm the roles and self-confidence of those “quiet” people, by asking them more questions and opinions. It was greatly important that no criticism was presented during the first planning sessions. Professor Mihaly Csikszentmihalyi (1934), a leader of the Drucker School of management, is perhaps best known of his Flow –concept (f.i. optimal challenges and quick positive feedback, no self criticism, no sense of time, autonomy, clear goals...). This idea of flow, the most convenient condition, is very close to those social aspects, needed in effective communication.

3.4 Organization culture

There are many ways to definite an organization culture. Carayannis (2001) brings forth two different point of views, Schein and Killman’s. Killman (1985) describes culture as” an invisible power” and” social energy” of an enterprise which, hiding back a real world, makes people act. According to Killman, for an organization, a culture means same than a personality for an individual – it is a hiding agenda, which creates ideas and instructions and brings *mobility* to an enterprise.

From Schein’s (1992) point of view, a vision of business culture is collective. He defines a culture as “divided basic assumptions”, which a team will learn and associate solving their internal and external problems. After becoming workable and valid enough, those problem solving ways will be taught to the new members of the group, so that for their part, they will be able to perform, think and adopt right in similar situations. According to Killman, people in organizations are being seen as individualistic subjects, factors, which focus their social energy on an object. Schein, for his part, sees a group as a factor, which passes down its erudition and accepted values to its new members. According to Iivari and Hirschheim (1996), a sociotechnical view includes elements from both of these perspectives. By thematic terms, a cultural research can be interpreted theoretically in many ways. After all, there is one common feature; reality world and social life (society) are transmitted to us above all by means of its meaning.

In this case we used both of those viewpoints. People were individuals with their own values, manners and ideas, but they *knew* that they also were team

players, for the good of their common working environment. In the next chapter, ETHICS – a socio technical approach is presented as a model of this collective view. Later, we will add more elements on that frame.

4. ETHICS – a socio technical approach

4.1 Why ETHICS

Both technical and economic points have traditionally dominated the thinking of system analysts and executives. When planning this training, we wanted to think the workers as specialists and innovators, who are committed to plan their new work processes with a consent and stimulus of their employer. From many designing methods Mumford's ETHICS (Effective Technical and Human Implementation of Computer - based Systems) was selected to inspect more carefully. Besides Ethics is an important part of the improvement and redesign phases, it also gives a grass root -level employee influence to take part in planning the information systems. As a classic method, it is also generally known in the field literature. As Pava's (1983) STS – method, it encourages future users to participate not just planning of the systems, but also control of the process. Furthermore, it pays attention to a work satisfaction and rearrangement and development of the work process. It can be compared to Contextual Design (CD) method, but Ethics stresses more workers' share and participation.

According to Davis, Olson & Langefors et al., Hirschheim, Klein & Lyytinen (1995) define an information system from two different viewpoints: a structure and an action. At the same, they will impress that the services produced by information systems are also partly dependent on human *capabilities* and *contributions* to common ventures of the information systems. Laudon & Laudon (2002) have also noticed those ethical, social and political aspects. They define five sectors of the information technology and -systems, which a present information society should notice. These sectors are 1) Information Rights and Obligations, 2) Accountability and Control, 3) Property Rights and Obligations, 4) System Quality and 5) Quality of life. Excluding some issues, which will be presented later, ETHICS, impressing as well as effectiveness as work satisfaction needs, suits well with the above thinking.

4.2 Three viewpoints of change

ETHICS offers three viewpoints for *a management of change*. It 1) legitimates every users' equivalent rights to participate in system planning from every organization level (job satisfaction, efficiency), 2) offers designers, besides technical and operational targets, means to set job satisfaction targets mentioned above (ascertain a successful use of the system) and 3) ensures that any new technical system will be appropriately integrated with an organization context (work processes, individual jobs and work group activities including the specification of roles and relationships within the department or functional area, boundary management techniques etc.) (Mumford, 1983).

The ETHICS method includes the following designing steps:

1. Set business and social needs, focusing on both short and long term efficiency and job satisfaction.
2. Identification and specification of best social and technical alternative.
3. Combine the alternatives into one socio technical option.
4. Arrange the options in regard to efficiency and social targets.
5. Examine the estimates of costs and financing of resources.
6. Choose the best socio technical option (Mumford, 1983).

4.3 There are no such thermostats...

According to Mumford, to achieve *equilibrium* in the practical use situations, the information systems are integrated with different kinds of organization components. At the same time their relations are made visible and stable (Figure 1.).

Juntunen, Participative Process Modeling as A Training Wheel

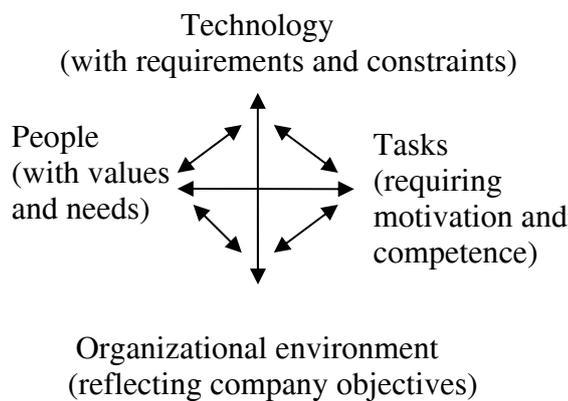


Figure 1. The equilibrium of systems (Mumford 1983, 15).

But, if we think a human being as a self – driven system, as we do in this study, equilibrium is not the right word to use. There are no such thermostats inside us, to condition our operations. Lyytinen, Mathiassen & Ropponen (1998) also impress the strong dependence of the parts of the socio technical model; change to one component causes either planned or casual transformations in the other components, too (causal dependency). Iivari (1991) criticizes ETHICS and Pava for that even they include a noticeable part of conceptual and structural development of methodology, they do not handle at all technological development. After all, he admits that ETHICS’s three explicit views of change, mentioned above, reflect also the benefits of an organization. In the next chapters, we will now link this technical process modeling part into the ETHICS context.

5. BPR and organizational learning

A process is ”lateral or horizontal organizational form, that encapsulates the interdependence of tasks, roles, people, departments and functions required to provide a customer with a product or service” (Earl 1994). There are many good definitions about process, but this one of Earl’s nicely characterizes a social technical character of a process.

5.1 From re-engineering to process management and business process modeling

Hammer & Champy (1993) defined business process reengineering (BRR) as a conceptually new, radical business model that has little or nothing in common with other improvement programs. This model suited primarily well in a manufacturing context, but nowadays a service sector is strongly entering along with its own demands. After all, in the real life context, a lot has been changed from that pioneer model of Hammer & Champy (Melão & Pidd, 2000). Still, one of the key words is *change*. The more we change a process, the more *systematic* it becomes. To understand, how radical changes are worth of doing, you have to look at the whole picture and see how things are connected together (Figure 2.).

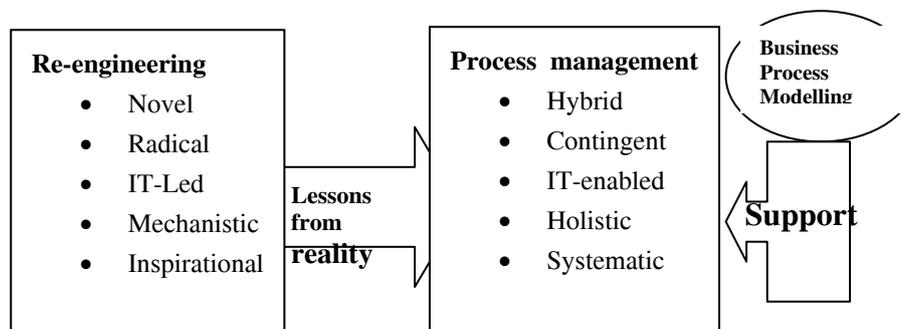


Figure 2. From re-engineering to process management and business process modeling. Melão & Pidd. Info Systems J (2000)10, 105-129.

Hugh Willmott (1994) has reviewed a business process re-engineering (BPR) vision of the radical business process change, focusing on the use of information technology to facilitate a shift away from linear/sequential work organization towards parallel processing and multidisciplinary teamworking. He also raises the

question: how human resource management (HRM) specialists will respond to the complexities and dilemmas associated with the re-engineering of work processes. In our discipline, this is a very interesting and rather an unexplored area, at least hitherto. In this study, the HRM people wanted to be along workers from the beginning of a first training session.

5.2 Enlarged model of participatory design

Joint Application Design (JAD®), the British “socio-technical systems” and Scandinavian “collective resources” have contributed to the current field of *participatory design* methodologies approaches. Depending on differing perspectives on workers, they integrated the end-users and their professional relationships to technology and stated goals.

If we now think about participatory design and its related methodologies, could we see and best understood them as an enlarged model which involves managers, users, designers, information and the technology itself, aiming at a work process development already in its early phase? Rather than seeing participatory design only as the insertion of public dialog within technological design practices, as several researchers have done, we would see it as a model for a motivated learning practice of workers.

5.3 Business process reengineering and organizational learning – studies in the field

BPR and organizational learning are two contemporary approaches for improving the capacity and effectiveness of organizations. Robey, Wishart & Rodriguez-Diaz (1995) have systematically compared the metaphors of BPR and organizational learning and propose an integrative approach that places reengineering within the context of learning. According them, reengineering conceives of organizations as mechanisms that can be redesigned to be more efficient, when learning regards organizations as complex living systems with cognitive and behavioral “memories.” They illustrate the limitations inherent in traditional reengineering with the case study of System One, a company in the

Juntunen, Participative Process Modeling as A Training Wheel

travel information services industry. The company's attempts to implement reengineered processes revealed a lack of attention to learning objectives and to planning for acceptance. Applied to System One, "the integrative model for organizational improvement provides a more appropriate beginning point for reengineering efforts and more specific guidance on the role of information technology in organizational learning."

Fiol & Lyles (1985) assessed systematic the strategic management literature and found an interesting dilemma: Although there exists widespread acceptance of the notion of organizational learning and its importance to strategic performance, no theory or model, related to that, is widely accepted. Instead, each subject, approached from different perspectives, has lead to more divergence. They present that the confusion stems as far as two decades ago, when Simon (1969) defined organizational learning as a growing insight and a successful restructuring of organizational problems, which reflected the structural elements and outcomes of the organization itself.

5.4 A Motivational Perspective

The Oxford English Dictionary (2005) defines motivation as "the conscious or unconscious stimulus for action toward a desired goal, especially as resulting from psychological or social factors". *Affect* is considered a critical component in addition to cognition in human decision making and behavior in many social sciences. Zhang (2005) thinks that people need ICT to support their personal and professional goals and activities that can be driven by various needs. Her *human-centric* assumption about ICT means that ICT are around people as holistic beings that exist in various contexts including organizations. Her paper has interesting approaches from the *design science* ("in order to achieve Y, do X") with the support of natural science results. She presents that the human-centric assumption warrants a motivational perspective to examine ICT related phenomena.

That, how formal (bureaucratic) an organization is, will have effects on the amount of written roles and standards – and this will contribute to a self-motivation of the staff. Routine and similar tasks are easy to standard and direct. According Juuti (1999) this may cause both advantages and problems. As benefits he finds e.g. the role clarity, stabile functions and added forecasting, the other side of coin may be that the organization will start action inflexible and rigidly. This

Juntunen, Participative Process Modeling as A Training Wheel

will cause a falling of a staff's motivation, because they are going to feel themselves controlled and they have no possibilities to work independently.

Zhang's (2005) message is that "human interaction with technologies should be driven by human's different levels of needs and goals". From the gap between satisfying organizational needs and supporting and enriching human users, we will get to Maslow's basic need hierarchy – sometimes said as an analog for an HCI maturity model and perceived quality of work. According that, Zhang refers to Maxwell (2002), who presents three levels of HCI maturity. These levels depict well a development of attitudes and work roles joining to the participative design:

Level 1 basic usability

Level 2 collaborative, organizational and role-based interaction

Level 3 individualized and holistic interaction.

6. Phases of the study

First thing to do was segment the heterogeneous staff according their work tasks and processes in the teams. After the nurses and doctors had been divided into the groups of three or four (there was 22 people present), and after they had become familiar with the idea of process modeling (we have had lessons f.i. of learning organization, information systems, technology and of course, processes and the idea of how and why do the modeling), they began step by step plan their own work processes, first with manual drawings and glue pads and then by using QPR-program. The idea was simplify the structure of tasks and make them technically visible. Surely, it is not easy to capture a reality of the situation, and try to reflect it back through some simple, drawn symbol. As an UML-example we used familiar "Heating Sauna" usecases. Constraints, both natural and artificial, and exceptions were also marked in a workflow.

I was allowed to observe the groups working and tried to answer their questions. It was delighting to see, how the groups, after they had interiorized the "clue", began to feel more commitment and maybe a little pride, too: "*I shall present this model to my boss, and I have now better arguments for my own idea...*" Sometimes it was really hard to try to explain, why every work tasks and phases had to be done so detailed. For instance: "*is it not apparent that when I order instruments from supplier, he will send them to me, it is his job, period –*

Juntunen, Participative Process Modeling as A Training Wheel

why do you want me to draw any more arrows in this ellipse...?” Sure he will, I said, but if the situation happens to be that there are no instruments left in the storage, what do you do then? “ Then... I don’t know...well, it depends on...”. Remember, I said, now *you* may suggest the best option for your team.”

One of the viewpoints of the sosio tehcnical designing method, ETHICS, was: legitimate every user’s equality rights to participate in system designing from every organization level. If the participants are not able to use power, the participation will stay just apparent. According Lucas (1994) it is an advantage of the new user that when participating, he/she at the same time will be able to control the operation; in a psychological mind, and will be an “owner” of the system. Because resources always are also a question of costs, Markus (1984) refers to Cherns (1976):

The boundary location principle states that departmental boundaries should be drawn in a way that entire processes can be completed within the department, for two reasons: to avoid excessive costs of coordination across departments and to encourage employees to take responsibility for their work.

Planning the information systems, Vehviläinen (1997) also emphasises that besides a participation of a personnel, work should be seen as a whole, which’s parts are connected, neither than single or divided tasks. Doing another way will just make an organization hierarchy stronger. And, the daily experiences of an employee should be connected in its real context to the other work unities of the organization. There are also opposite viewpoints. Iivari & Iivari (2006) have analyzed the variety of meanings of user-centeredness in the extant literature. They see user-centeredness as a multidimensional concept of which one part is user participation. They refer f.i. to Cooper, who likes to exclude real users from the major part of design process and instead of that, use “personas” as surrogates of users. If we speak about user participation, it is overriding important to notice: *what* we are developing and to *whom*. Are we dealing with commercial software products that are intended to serve millions of people (Pruitt & Grudin, 2003) – or as in this case, are we looking for bottlenecks in *workflows* and possible mobile or digital solutions, f.i. small, stand-alone applications for specialists’ work tools.

In the moment, April 2007, the groups still continue a modeling phase. Their codification consists in translating knowledge into symbolic representations. According David & Foray (2003) : “This creates new cognitive potentialities that remain inconceivable so long as the knowledge is attached to individual human

beings and, hence, only heard (when spoken) or seen (when put into practice) through interaction with those carriers.”. After getting workflows ready, every group will have a control session with their principals, IT controller and us. Then, I hope to get some data feedback from a cyclical process. The next step will be to start analyzing together those models, trying to find bottlenecks, and better solutions. So, the employees are not just observed and interviewed objects as is the case f.i. in Contextual Design method. We may say that with the managers, those pioneer teams have formed a one, very important stakeholder group in their own work context. Maybe not so much for political reasons, but for the pure interest to learn new ways to express their selves clearly (speak same language than IT people) and get things go to right direction.

7. Outcomes and questions so far...

This paper represents “work-in-pogress” in its early phase and is integrated with the prior researsh literature. Based on that and my own action research experiences, it seems that BPR overlaps with socio-technical (participative) design quite well. Open co-operation between different disciplines and professionals went nicely and was educational for both of us. The maturity of the groups’ understanding of the whole picture and especially the effect of combining certain process features with management interventions grew clearly.

We do not know yet, is QPR such a user-friendly and effective tool enough to support non-technical personnel in visualization and participation in process modeling. Also we can not be sure, do the workers’ time and patience be adequate enough to get all information needed into their models. In the future, it remains to be seen: how well does this organizational and individual knowledge utilize the work society and do these new processes provide quality service for the patient and *healthcare professionals*. At the end, it is always a customer, who decides the value of the service.

8. Summary

If we would think in traditionally way, why public sector organizations and services exist, we may say, that they produce legitimacy and correct of market

Juntunen, Participative Process Modeling as A Training Wheel

failures, enabling opportunities and welfare equally for all the citizens. Another side of the coin, I argue, are those faceless, heavy and hierarchical *structures* of public sector organizations. They are those barriers, which block all that knowledge and motivation of personnel, which is needed to develop and improve the work processes and at the same, the work satisfaction of individual persons.

The codification of knowledge in information modeling and planning is coming more and more important topic. The amount and complexity of information and its numerous abstraction levels: organizations, units and independent users, demand researchers and designers develop new forms of co-operation for digging out and dividing essential information. Because information is acquired from many different sources, various methods and tools, as well as a familiarity of an organization culture, including the whole history of the domain, are needed.

Reaching that goal, introduction of all recourses and indicators - a research, a realization and a personnel real participation will be indispensable. As Juuti (1999) states it: " When a competent society demands creative and capable thinkers, a mechanical structure of the organization will do no more." When a fixed and rigid approach does not work, services have to take a more complex approach to early intervention. Doing so, insights can be generated seeking answers through practice by practitioners and improvements will be based on those insights. This can promote a positive attitude to change and improve internal operations and clarified peoples' roles. And, of course, it gives rise to learning and new practices to identify barriers and gaps and prevent overlaps in services in early intervention outcomes. This local "know how" can then be added to an evidence base database, which will be utilized and supplemented in the future. In the course of time, those local answers may turn out as "good practices" to support policy development and influence the design of innovative work processes.

A study indicated that the employees want more independence and authority than a mechanical (machine) organization structure is capable to offer by now. According this, people also want enhance their work tasks and be more self-motivated. Giving authority, such as learning self control, is a continuous process. Confidence is, after all, a key element, which feeds this kind of synergy. Besides new methods and technologies, does it also demand the change of a power structure – we will see.

Juntunen, Participative Process Modeling as A Training Wheel

A world, with turbulence and change as a daily reality, brings enormous challenges to leaders and managers. They have to rethink their roles and forge new ways of recognizing and organizing those processes strategic to their existing. The transition to today's new information economy still needs a companion. As a pro-active, multidimensional approach this *socio-economic-information-technical* viewpoint seems promising alternative to give novel insights, and maybe, after more empirical evidences, a chance for theory development.

“...The notion of praxis became even more salient for me because through playing jazz, the musician is simultaneously exploring and negotiating the boundaries of theory and practice.” Adrienne D. Dixson, 2005

References

- Carayannis, E. G. (2001). *Strategic Management of Technological Learning*. Florida: CRC Press
- Checkland, P., and Scholes, J. (1990). *Soft Systems Methodology in Action*. Chichester: John Wiley.
- David, P.A., Foray, D. (2003). “Economic Fundamentals of the Knowledge Society”. *Policy Futures In Education – An e-Journal*, 1(1) Special Issue: ”Education and the Knowledge Economy”, (draft 1.2.2002, 5.).
- Davis, G. B. and Olson, M. (1985). *Management Information Systems – Conceptual Foundations Methods and Development*. (2nd). ed. New York: McGraw-Hill. *Refered* Hirschheim, R., Klein, H. K. & Lyytinen, K. (1995). *Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations*.
- Dixson, A. D. (2005). “Extending the Metaphor: Notions of Jazz in Portraiture”. *Qualitative Inquiry* 2005; 11; 106.
- Earl, M.J. (1994). “The New and Old of Business Process Redesign”, *Journal of Strategic information Systems*, (3:1), 13.
- Fiol, C. M., and Lyles, M. A. (1985) “Organizational Learning”, *The Academy of Management Review*, vol. 10, no. 4 (Oct., 1985), 803-813
- Hirschheim, R., Klein, H. K. and Lyytinen, K. (1995). *Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations*. Cambridge: University Press.

Juntunen, Participative Process Modeling as A Training Wheel

- Hyppönen, H. (2004). "Tekniikka kehittyy, kehittyvätkö palvelut?" Tapaustutkimus kehittämisestä teknologiahankkeessa. *Tutkimuksia* 134. Gummerus kirjapaino Oy. Helsinki: STAKES, 5-25.
- Iivari, J., and Hirschheim, R. (1996). "Analyzing Information Systems Development: A Comparison and Analysis of Eight IS Development Approaches". *Information Systems*. Vol. 21, No. 7, 551 -575.
- Iivari, J., and Iivari, N. (2006). "Varieties of User-Centeredness", *IEEE Proceedings of the 39th Hawaii International Conference on System Sciences*, 1-9.
- Iivari, J. (1991). "A paradigmatic analysis of contemporary schools of IS development". *Eur. J. Information. Systems*. Vol. 1, No. 4, 249 – 272.
- Juuti, P. (1999). *Organisaatiokäyttäytyminen: Aavaranta - Sarja18*. Keuruu: Otavan Kirjapaino Oy.
- Järvinen, P. (2007a). On reviewing of results in design research. ECIS 2007. accepted paper.
- Killman, R. (1985). "Gaining Control of the Corporate Culture". New York: McGraw-Hill.
- Refereed Carayannis, E. G. (2001). *Strategic Management of Technological Learning*. Florida: CRC Press.
- Langefors, B. (1973). "Theoretical Analysis of Information Systems". Philadelphia: Auerbach.
- Refereed Hirschheim, R., Klein, H. K. & Lyytinen, K. 1995. *Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations*.
- Laudon, K. C. and Laudon, J. P. (2002). *Management Information Systems*. (7th). ed. New Jersey: Prentice-Hall.
- Longman Group Ltd. (1995). Dictionary of contemporary ENGLISH (3rd). Ed. Great Britain: Clays Ltd.
- Lucas, JR. and Henry C. (1994). *Information Systems Concepts for Management*. (5th). ed. San Francisco, CA. : Mitchell Publishing, Inc.
- Lyytinen, K., Mathiassen, L. and Ropponen, J. (1998). "Attention Shaping and Software Risk – A Categorical Analysis of Four Classical Risk Management Approaches". *Information Systems Research*. Vol.9, No. 3, 233 – 255.
- Markus, M. L. (1984). *Systems in Organizations. Bugs + Features*. London: Pitman.
- Martikainen, O., Autere, J., Elonen, R., Lehtinemi, U., Nurmela, M., Torniainen, A., "Performance improvement in public organizations, How to leverage ICT investments", White paper, draft 5.12.2005.
- Melão, N., and Pidd, M. (2000). "A conceptual framework for understanding business processes and business process modeling", *Info Systems*, J 10, 105-129.
- Mintzberg, H. (1983). *Structure in Fives. Designing Effective Organizations*. New Jersey: Prentice-Hall.
- Mumford, E. (1983). *Designing Human Systems for New Technology. The ETHICS Method*. England: Manchester Business School.
- Pruitt, J., and Grudin, J. (2003). "Personas: Practice and Theory", *Proceedings of the 2003 conference on Designing for user experiences 2003*, San Francisco, California, June 06 - 07, 2003.
- Robey, D., Wishart, N. A., Rodriguez-Diaz, A. G. (1995). "Merging the metaphors for organizational improvement: Business process reengineering as a component of organizational

Juntunen, Participative Process Modeling as A Training Wheel

- learning”, *Accounting, Management and Information Technologies*, vol. 5, Issue 1, January-March 1995, 23-39.
- Schein, E. (1992). *Organizational Culture and Leadership*. New York: Jossey Bass. *Refered*
- Carayannis, E. G. (2001). *Strategic Management of Technological Learning*. Florida: CRC Press.
- Stacey, R.(1993). *Strategic Management and Organisational Dynamics*. London: Pitman.
- Vehviläinen, M. (1997). *Gender, Expertise and Information Technology*. University of Tampere. Department of Computer Science. Doctoral dissertation.
- Willmott, H. (1994). ”Business Process Re-engineering and Human Resource Management”, *Personnel Review*, Vol. 23, no. 3, 34-46.
- Zhang, P & U.Y.Eseryel (2005). “Task in HCI Research in MIS Literature: A Critical Survey”, *Proceedings of the Human-Computer Interaction International conference (HCII)*, Las Vegas, NV, July 22-27, 2005.
- Zhang, P., Carey, J., Te’eni, D., and Tremaine, M. (2005) “INTEGRATING HUMAN-COMPUTER INTERACTION DEVELOPMENT INTO THE SYSTEMS DEVELOPMENT LIFE CYCLE: A METHODOLOGY”. *Communications of the Association for Information Systems*, vol.15, 512-543.

Mass Customization and e-Tailing: Implications to Virtual Furniture Mass Customization

Taina Kaapu
University of Tampere, Finland
taina.kaapu@uta.fi

Kyösti Pennanen
University of Vaasa/Epanet, Finland
kyosti.pennanen@uwasa.fi

Abstract. Companies need new strategies to react customer's desires efficiently for the development in the global competition. The aim of this paper is to offer conceptual building blocks for further studies and practice related to the strategy of virtual mass customization in the field of furniture. We discuss the concept of mass customization and the near concepts of it. Moreover, we present a new opening in information systems research field: the Furniture Fitting-Room (a prototype for presenting three dimensional models of furniture in a virtual reality environment) is an example of virtual furniture customization. With this example, we open and clarify the concept of mass customization in the furniture e-tailing context further.

Keywords. Mass Customization, e-Commerce, Virtual Reality, Furniture e-Tailing.

Introduction

The increasing interest to use e-commerce has produced a corresponding need to provide additional customer-related service online (Levenburg and Klein 2006). Even if a sale is not fulfilled online, the literature in information systems science, marketing and management stress the importance of the internet in other phases of customer's buying process (e.g. Chen 1998; Walsh and Godfrey 2000; Zeithaml 2002; Zhou, Dai and Zhang 2007). This process includes for example search of sources, evaluation of alternatives and customer support. At the same time, companies are being forced to react to the demand of growing individualization (Piller 2004) and online services can be used also for this need.

Companies have to adopt strategies which embrace both: 1) a closer reaction to the customers' needs, and 2) efficiency to add value to their services (Piller 2004). Customers perceive the value in their inner processes and in the interaction with the supplier or service provider when they consume or use the services, products, information, personal contacts, normalization, and other elements of a long-lasting relationship (Grönroos 2001). One way to address customers' needs and add value to the service is mass customization which enables customers to buy personalized products and manufacturer to enjoy the benefits of mass production.

According to Luomala and Lindman (2006), furniture are profitable targets for the value creation since a piece of furniture usually embodies many meanings for consumers as a member of a design-intensive product category. Therefore, from a customers viewpoint furniture elicit different desires and expectations, which can, and need, to be fulfilled. Finnish furniture industry needs new strategies for progress in the global competition.

In the time of the globalization, the Finnish furniture industry has changed: the furniture retailing chains have grown and there are more manufacturers from abroad competing in the Finnish markets (Lindman 2005). By the influence of media, the consumers' interior tastes transform and the models of purchasing furniture change more rapidly than before (Ahonen 2003). The business-to-consumer (B2C) furniture retailing has grown four years in a row in the year of 2006. The growth is expected to continue in the near future. However, Finnish furniture industry has faced challenges; furniture export has decreased last year almost 14 % down to 244 million euros. At the same time, the import of furniture grew almost to 17 % up to 334 million euros. Much of the furniture is from China and Poland. (Kauppa- ja teollisuusministeriö 2006.)

Furniture industry needs to answer to the challenges it faces. e-Tailing (retailing that uses the Internet as a medium for customers) and the strategy of mass customization together may play an essential role in the present business environment. The idea of mass customization is seen as "ability to use of flexible processes and organizational structures to produce varied and often individually customized products and services at the price of standardized, mass produced alternatives" (Hart 1996). In the e-tailing context, customers may, for example, design furniture virtually before the real manufacturing process begins through own computer. This adds value for both the customers and the furniture industry. Customers may have a possibility to see how the product fits in their interior before the actual purchase and the furniture industry could, for example, gain cost-savings when the need to maintain warehouses decreases.

At this moment, there exist only few, if any, possibilities to virtual mass customization within the furniture industry. Combined with the limited amount of academic research in the field results to both practical and academic need to address the issue. Thus the aim of this paper is to offer conceptual building blocks for further studies and practice related to the virtual furniture mass customization.

Firstly, we discuss the concept of mass customization in general and the near concepts of it. The distinction between the concept of mass customization and four other concepts (differentiation, personalization, consumer creativity, and co-design) is made in order to clarify the differences and to avoid confusion between these five, quite alike, concepts. Secondly, we use the prototype of the Furniture Fitting-Room (a prototype for presenting three dimensional models of furniture in a virtual reality environment) as an example of virtual furniture customization. With this example, we open the concept of mass customization in the furniture e-tailing context further. Thirdly, we provide implications for further research based on the discussion in the paper.

Definition of Mass Customization

Historical evolution has gone through different phases starting from craftsmanship, evolving to mass production and process improvement, and lately to mass customization (Pine 1993). Companies have to adopt strategies, which combine closer reaction to the customer's needs and companies' efficiency (Piller 2004). The concept of mass customization was anticipated by Alvin Toffler (1971) and coined by Stan Davis (1987). Pine (1993) suggested a business model that he called the 8-figure-path which describes the process from invention to mass production to continuous improvement to mass customization and back to invention.

The idea of mass customization is also seen as "ability to use of flexible processes and organizational structures to produce varied and often individually customized products and services at the price of standardized, mass produced alternatives" (Hart 1996). Jiao and Tseng (2004) define mass customization as "producing goods and services to meet individual customer's needs with near mass production efficiency". Kaplan and Haenlein (2006) define mass customization as "a strategy that creates value by some form of company-customer interaction at the fabrication or assembly stage of the operations level to create customized products with production cost and monetary price similar to those of mass produced products". In a nutshell, based on the previous three well-established definitions, we understand mass customization as the benefits of mass production combined with the added value for customers.

Mass customization may be carried out with various methods, which combine different options for customization while maintaining the cost option (Piller 2004). According to Feitzinger and Lee (1997) modularization can be regarded as the central principle of mass customization: "a product with a modular design provides a supply network with the flexibility that it requires customize a product quickly and inexpensively".

Several modes of mass customization have been identified in the previous research. Since the focus of our paper is in the furniture industry, we will use furniture examples for demonstrating the purpose. Gilmore and Pine (1997) have identified four types of mass customization: 1) collaborative customization, 2) adaptive customization, 3) transparent customization, and 4) cosmetic customization. Collaborative customization means that the furniture enterprise has a dialogue with customers to specify their needs in order to generate a customized offering that fulfills those needs. The information gathered in discussion is then used to specify and manufacture a piece of furniture that suits that specific customer. For example, the furniture company will manufacture a bookcase that fits precise to customer's home by dimensions and interior style. According to Gilmore and Pine (1997), this kind of customization is most often associated with the term mass customization. Adaptive customization is used when the furniture enterprise manufactures a standardized piece of furniture, but this product is customizable in the hands of the end-user. For example, the customer can change the color of the table on his/her own depending on some specific need or situation. Transparent customization means that the furniture enterprise provides individual customers with unique furniture, without explicitly telling them that the products are customized. In this case, there is a need to accurately assess customer's needs. In cosmetic customization, the furniture enterprise manufactures a standardized piece of furniture, however, the retailer markets it to different customers in unique ways.

From the four different types of mass customization, the collaborative customization is adapted in the example of this paper, because it emphasizes customers' needs and the dialogue between the manufacturer and the customer. Based on the co-operation both parties can benefit which creates added value for both. The main idea behind the Furniture Fitting-Room also emphasizes the dialogue between customer and manufacturer in order to benefit both parties. In contrast, the other three types of mass customization are more either customer-specific (adaptive customization) or manufacturer-specific (transparent- and cosmetic customization) and thus lack the actual dialogue between the parties and miss the advantages enabled by co-operation. For that reason, they could not serve as foundation for virtual mass customization as meant in this paper.

Boundaries to Close Concepts

As discussed in the previous section, mass customization means the production of personalized products to meet the customer's needs without losing the benefits of mass production. In this section, the distinction between the concept of mass customization and four other concepts (differentiation, personalization, consumer creativity, and co-design) is made in order to clarify the differences and to avoid confusion between these five, quite alike, concepts.

Differentiation. From a strategic point of view, mass customization means differentiation through customization, that is the production of goods in so many variants that the wishes of each relevant customer are fulfilled (Piller 2004). In marketing, product differentiation is the modification of a product to make it more attractive to the target market. This involves differentiating it from competitors' products as well as one's own product offerings (Lindman and Peltoniemi 2006). The changes in products are usually minor. They may be merely a change in packaging or also include a change in advertising theme. The objective of this strategy is to develop a position that potential customers will see as unique. In this case, marketing mix is in use and the background is other than consumer's personal experience.

As seen in the definition of differentiation, the concept includes the actions performed individually by the manufacturer. The main difference of differentiation compared to mass customization is that it is more a marketing action. Unlike in the mass customization, customers do not have active role in the actions but they are merely the targets of the actions.

Personalization. Personalization is not the same than mass customization. Personalized marketing (also called personalization, and sometimes called one-to-one marketing) is an extreme form of product differentiation (Kekre and Srinivasan 1990). Whereas product differentiation tries to differentiate a product from competing ones, personalization tries to make a unique product offering for each customer.

The main distinction between personalization and mass customization is similar than it was in the case of differentiation; the dialogue between the manufacturer and customer is missing. More specifically, personalization does not strive for similar result as mass customization but rather personalization is (such as differentiation) a marketing action performed by manufacturer. Customers' role in the relationship is to be, more or less, a target of the actions

Consumer creativity. As a phenomenon, the creative consumer has a long history. It is as old as products and services themselves. The car industry serves as an excellent example of products that has existed in a generally symbiotic relationship with creative consumers. Burroughs and Mick (2004) define creative consumption as "a departure from conventional consumption practice in a novel and functional way". Berthon et al. (2007) define the creative consumer "as an individual or group who adapts, modifies, or transforms a proprietary offering, such as a product or service."

Research on creativity and the creative process provides the starting point for identifying specific variables likely to affect new product innovativeness. What is essential is that the product be used, changed, or combined in a manner that is contrary to typical forms and applications, including possibly the manufacturer's intent (Burroughs and Mick 2004). In the context of consumption, novelty might entail a new use for a product, for example a user interface. However, it could also

involve altering the form of a product, perhaps to affect its performance. Or it might involve combining two or more products in a nonstandard manner.

The main difference between the concept of consumer creativity and mass customization is that the result of consumer creativity is usually a completely new product. Also the lack of interaction between the consumer and the manufacturer differentiates the two concepts, as was the case in differentiation and personalization. This time only the actor (consumer) is different.

Co-Design. Co-design is applied in many fields, for instance architecture, information systems and business. It has recently become popular in mobile phone development, where the two perspectives of hardware and software design are brought into a co-design process. In the co-design, consumer creativity is needed.

In co-design, the designer must have a sensibility to enter into the consumer's emotions and everyday experience. The designer also has to have the skills to research the everyday experience and tastes of different kinds of consumers: young, old and middle-aged people; poor, rich and middleclass people. The designer has to be capable of reading a variety of meanings of different cultural and visual discourses within different people understand the same material object. (Takala-Schreib 2000.)

In the previous discussion, co-design was found to be more or less consumer's and designer's innovative process to develop new products. It is purely directed to develop new products such as mobile phones which differentiates it from mass customization. In mass customization the product already exists, consumer just modifies the product to meet his/her needs which is not the case in co-design.

Contribution to Practice: Furniture e-Tailing

We outlined mass customization in general and also comparing other related concepts. Next we discuss mass customization in the furniture e-tailing context and we use the Furniture Fitting-Room (a prototype for presenting three dimensional models of furniture in a virtual reality environment) to clarify the concept.

From the information and communication technology (ICT) point of view, Silveira, Borenstein, and Fogliatto (2001) analyzed the body of mass customization studies and found a well-established focus on computerization and interconnectivity as the key technological enablers of customized production processes. In short, while the computerization of design and manufacturing processes made possible greater product variety and shorter product life cycles, the interconnectivity offered by networks served to facilitate the exchange of information between production modules. The enabling role of production modules emphasizes an explicit link to advances in the modularization of product design and assembly. As Pine, Victor, and Boynton (1993) originally emphasized,

increased modularization allowed components to be more efficiently mixed in various combinations so as to better meet individual customer needs.

Today, mass customization research is at the stage of investigating and understanding how the concept can be used across different sectors (MacCarthy, Brabazon and Bramham 2003). However, existing manufacturing and information systems are based on standardization approaches and they provide little support for moving from mass production to more personalized products (Geerdink 2006).

Many firms from various industries nowadays practice ICT-based mass customization. The car industry is one of the furthest in the development. In several web-based services, the customer may pick all the features to his/her own new car. After this, the car is customized according to the customer wishes. Furthermore, it is possible to customize almost anything. For example, consumers can customize men's wear, women shoes, PCs, watches, jeans, sport shoes, and the packaging of chocolates (Piller 2004).

Interaction systems for mass customization are the most important instrument to reduce costs. These systems are known as configurators, choice boards, design systems, toolkits, or co-design platforms and they are responsible for guiding the user through the configuration process. Different variations are represented, visualized, assessed and priced which starts a learning-by-doing process for the user. However, the success of such an interaction system is not only defined by its technological capabilities. In addition, system's 1) integration in the whole sale environment, 2) ability to allow for learning by doing, 3) ability to provide experience and process satisfaction, and 4) integration into the brand concept are important aspects (Franke and Piller 2003.)

Mainly web-based e-commerce services are used for customization. However, there are a number of techniques and efforts to exploit user experienced environments and three-dimensional applications. For example Dai et al. (2006) present a web-based order system that provides a three-dimensional interactive custom mechanism in the traditional computer screen to get customers' input and enable businesses to implement mass customization. The custom inputs are incorporated through assembly or production to provide customers with products as they demand. In the system, for example beach vehicles or mobile phones are available for customization.

Besides of other products, furniture is the field where ICT-based virtual mass customization could be used. In the time of the globalization, the situation in the furniture industry has changed: the retailing chains have grown and there are more manufacturers from abroad competing in the Finnish markets (Lindman 2005). By the influence of media, the consumers' interior tastes transform and the models of purchasing furniture change more rapidly than before (Ahonen 2003). On the one hand, demand for more individualized furniture and improved quality have increased. On the other hand, cheaper furniture prices and faster delivery are expected. In the field of furniture, product life cycles have shortened at the same

time. These challenges can be reached by answering quickly consumers' new needs. Hence, furniture retailing (in e-commerce e-tailing) needs new viewpoints and innovations for development.

The idea of mass customization is not completely new for furniture industry, however, the idea should be used more efficiently. At the moment, there is a common way in the furniture retailing that, for example, a customer sees a concrete sofa in one color in a traditional marketplace and after six or eight weeks receives his/her own home in chosen color. Some of the problems of this procedure are that the possibilities for changes are limited, the customer sees only a small sample of desired fabric or leather (it may be difficult to understand the whole sofa covered with the small sample), and the procedure takes so long time from a consumer point of view.

Also e-commerce marketplaces have become more and more popular to purchase furniture regardless the problem of trying the piece of furniture. Even in a traditional marketplace it is difficult because the customers do not see the sofa in their own home. For example, a piece of furniture looks like really different when the marketplace is usually very large compared to the home environment. However, the manufacturers and the retailers are interested in moving their processes towards e-commerce at the moment. For example, they have developed web-based services for presenting the current interior from the photograph in different colors or for visualization of different kinds of curtains.

As a new answer to the previous challenges in furniture industry, we next present the main ideas of the Furniture Fitting-Room. In this paper, we use the Furniture Fitting-Room as an example to clarify the concept of mass customization. The fitting-room can be understood as a part of a new interaction system required by the strategy of mass customization.

Mass Customization in the Furniture Fitting-Room

The prototype of Furniture Fitting-Room is developed during a multidisciplinary research project (furniture design, virtual technology and its human aspect). Virtual reality (VR) gives users the sensation of being part of a three dimensional (3D) environment with which they are able to interact (Dai et al. 2006). The central component of VR systems is the three dimensional computer generated graphical models of real, abstract or imaginary objects and environments (Bowman, Gabbard and Hix 2002). In our case, the models of furniture are visualized to users in an apartment in the virtual environment (VE). It means taking a user in a virtual space by using a room (of a size 3 m x 2,4 m), which floor, ceiling and three walls are computer screens (see Figure 1, Figure 2).

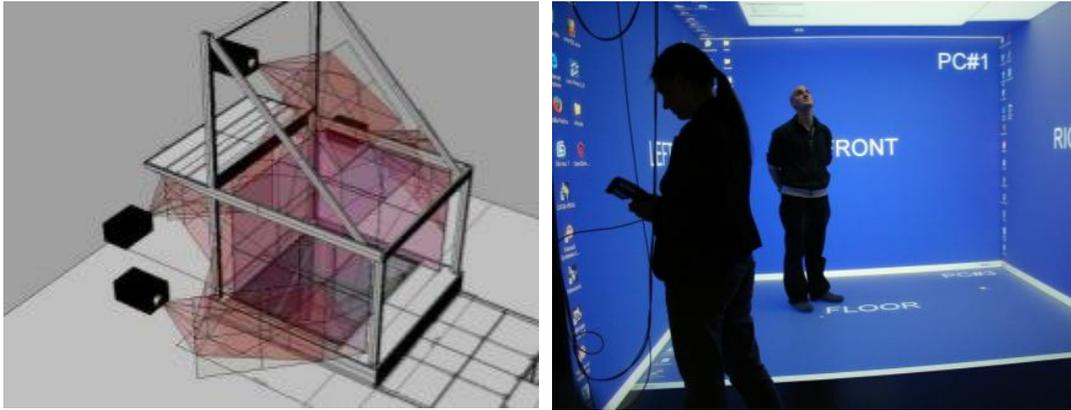


Figure 1. The architecture of VR laboratory (Laboratory of Virtual Technology 2006). Figure 2. The Cave-like environment inside.

The 3D models of furniture are presented in this Cave-like environment¹ where the visual display is created by projectors positioned outside the cube. In the Furniture Fitting-Room, the user sees different rooms and has a possibility to change furniture and move them in the room (see Figure 3). Physical movements from a user affect to the view and the display can be seen from different perspectives. To be able to use the floor and ceiling projection effectively, the image needs to be produced in active stereo with different polarisation systems. In the Cave-like environment, the user may take a glance behind a virtual corner and take a look under a virtual table. This gives the user an immersive feeling of actually being in this apartment even though he/she is not.

An active stereo image will be rendered so that each eye will see its own image with liquid crystal shutter glasses at a frequency of 2×45 Hz (used to switch them on and off repeatedly 96 times per second). The refresh rate of the projectors is synched up with the flicker rate of the shutter glasses so that every other projected frame alternates between a left eye and right eye image. The shutter glasses block out the image not intended for the blocked out eye, effectively supplying each eye with its own personalised and customised 3D image. In the Furniture Fitting-Room, the user wears the shutter glasses and by a control unit a piece of furniture may be moved to different places and colors or materials are possible to change there (see Figure 4).

¹ CAVE is a trademark of the University of Illinois at Chicago. In this paper, we use the term Cave-like environment to describe the generic technology rather than the specific commercial product.



Figure 3. 3D models of furniture in the Furniture Fitting-Room.



Figure 4. User with stereoscopic shutter glasses and a control unit.

As mentioned earlier, our idea is that collaborative customization is the mode of customization strategy concerning the Furniture Fitting-Room. It means that the furniture enterprise determines the precise product offering that best serves the customer's needs. This information is then used to specify and manufacture a piece of furniture that suits that specific customer (for example, color, material design etc.). The Furniture Fitting-Room serves as a new way of communication between furniture e-tailer and customer. Compared to the going to the concrete marketplace and choosing the right furniture from the assortment or the catalog, the Furniture Fitting-Room offers more advantages, for example, to see the furniture in 3D and to modify textures easily.

Conclusion

Mass customization raises many implications for theory development and testing across a broad horizon. In our paper, we offer conceptual building blocks for further studies and practice in virtual furniture mass customization. Although the notion of pursuing a customization strategy is appealing, the current theoretical efforts in the literature towards mass customization have only highlighted its benefits while neglecting the means (Jiao, Ma and Tseng 2003). Moving from mass production towards mass customization requires new ways to communicate with customers and we offer one way: the prototype of the Furniture Fitting-Room. The prototype was presented to illustrate the concept of mass customization.

In the Furniture Fitting-Room, the aim is to support consumers' participation to furniture development process by using technology. The technology helps consumers to understand and negotiate of a furniture 3D-model and make easy and cost-effective changes. In the future, the Furniture Fitting-Room and its development offer considerable benefits to furniture manufacturers, retailers and

customers. Firstly, the furniture manufacturers get feedback efficiently related to their plans and forthcoming models. Secondly, the retailers are able to show to their customers many more furniture models that are possible to keep in a stock. Thirdly, the customers have a possibility to affect to the furniture design process and other challenge is a possibility to modify furniture like the customer wishes, for example fit different textiles on a sofa or get a higher bookcase or a broader sofa than in the catalogue.

There will be possibilities to try a piece of furniture virtually in own home and see how it looks like as a part of own interior. If the available models of furniture do not seem to fit then the consumer may make own modifications. When the furniture manufacturer has received enough large amount of same kind of modifications, the manufacturer fulfills the orders. In a more advanced situation, the furniture manufacturer uses automatic system that produces the needed piece of furniture without unnecessary extra costs. However, the main idea of mass customization is to “produce varied and often individually customized products and services at the price of standardized, mass produced alternatives” (Hart 1996).

As there exist benefits, also limitations occur. Due to the lack of empirical studies related to the technology or the idea of the Furniture Fitting-Room, there exists no knowledge in how consumers perceive such a technology. Also the limitations in current technology generate obstacles. For example, the Cave-like environment needs plenty of room and the placement of technology arouse questions. Naturally, the best place for the Furniture Fitting-Room would be consumers’ own home but at this moment the idea is not realistic. Also the price of the current technology is relatively high which could be considered as a barrier to commercializing the Furniture Fitting-Room.

Furthermore, the concrete production process of mass customized products needs further development although there already exist some efforts to fill customer’s wishes and desires. Traditionally, furniture manufacturing is a low-tech industry, in which ICT is hardly used. Furniture industry is a design intensive sector, but most of the small and medium enterprises (SME) in home furniture production are focusing on handicraft skills instead of conceptual thinking and customer-centered approach. However, there is a common way in the furniture retailing that, for example, a customer sees a concrete sofa in one color in a traditional marketplace and after six or eight weeks receives his/her own home in chosen color. These kinds of systems should be developed further for the strategy of mass customization.

Although we face some limitations related to virtual furniture customization, we argue that the benefits are such impressive that future research is justified. When technology matures and cheapens consumers may exploit the fitting-room or other similar technology in their own homes (e.g. via home theatre-systems) and use their own interior as model in the fitting-room. At that stage, the benefits of the fitting-room will realize, for both to the consumers and the manufacturers.

Implications for Further Research

In the current paper, a virtual Furniture Fitting-Room for mass customization has been introduced. In the current stage of the virtual mass customization research, the focus of the research is mainly on conceptual level. In order to shift the focus on the empirical side of the research, we will offer some proposals how virtual mass customization could be approached empirically.

Due to the novelty of the technology (Cave-like environment or similar technologies) it is important that the empirical research concentrates on consumers' views on the technology. For example, researchers could expose consumers to the Furniture Fitting-Room in order to elicit their perceptions of the technology. In practice, this means that consumers' views could be approached via observation and interviews. Consumer-oriented approach could be useful when developing new and more impressive technology for furniture mass customization. Especially consumers' views on the advantages and disadvantages of the technology could be seen very important in order to add value in future services and to avoid useless and confusing technological features which in the worst case would hinder the development of final services and consumers' adoption of technology.

As discussed earlier, the Cave-like environment or the Furniture Fitting-Room are not the only options to conduct virtual furniture mass customization. For example, web-based services are already used for multiple products and purposes. To compare different services, comparative studies could be done. For example, experiments in which consumers customize furniture in different virtual environments (such as web-based mass customization or the Furniture Fitting-Room) could be useful to study consumers perceptions related to different technologies. This kind of approach could be beneficial because it might provide suggestions about the technology, which consumers prefer.

Previous two examples dealt with consumer. As discussed earlier, mass customization emphasizes the dialogue between customer and manufacturer which makes the issue as two-folded. Thus it is important to gain understanding about retailers' and manufacturers' perceptions of virtual mass customization too. Indeed, there is still a lack of knowledge what kind of advantages and disadvantages retailers and manufacturers perceive in virtual mass customization. Do they consider the benefits, for example, the ones brought up in this paper as useful and interesting? Whatever the matter, both sides of mass customization should be studied in order to develop services that add value for consumers, retailers, and manufacturers. In the end, mass customization is a phenomenon that allows consumers, retailers, and manufacturers to gain benefits. At this moment, the main question is how the possible win-win situation could be reached.

Acknowledgments

The authors would like to gratefully acknowledge Dr. Tarja Tiainen and three anonymous IRIS30-reviewers for their helpful comments on the earlier version of this paper.

References

- Ahonen, A. (2003). *Huonekalualan skenaariot*. Divan-tekniologiaohjelman jälkeinen kehittäminen toimialalla (in Finnish, Scenarios in the field of furniture. The development in the branch after the program of technology Divan). Divan-työryhmän raportti 1, Tekes.
- Berthon, P.R., Pitt, L.F., McCarthy, I., and Kates, S.M. (2007). "When customers get clever: Managerial approaches to dealing with creative consumers", *Business Horizons* 50, pp. 39-47.
- Bowman, D.A., Gabbard, J.A., and Hix, D. (2002). "A survey of usability evaluation in virtual environments: classification and comparison of methods", *Teleoperators and Virtual Environments Archive*, ACM Press, vol. 11, no. 4, pp. 404-424.
- Burroughs, J.E., and Mick, D.G. (2004). "Exploring antecedents and consequences of consumer creativity in a problem-solving context", *Journal of Consumer Research*, vol. 31, no. 2, pp. 402-411.
- Chen, W-H. (1998). "Benchmarking quality goals in service systems", *The Journal of Services Marketing*, no. 12, pp. 113-128.
- Dai, K., Li, Y., Han, J., Lu, X., and Zhang, S. (2006). "An interactive web system for integrated three-dimensional customization", *Computers in Industry*, vol. 57, no. 8-9, pp. 827-837.
- Davis, S. (1987). *Future Perfect*. Addison-Wesley, Reading.
- Feitzinger, E., and Lee, H. (1997). "Mass customization at Hewlett-Packard: the power of postponement", *Harvard Business Review*, vol. 75, no. 1, pp. 116-121.
- Franke, N., and Piller, F.T. (2003). "Key research issues in user interaction with user toolkits in a mass customisation system", *International Journal of Technology Management*, vol. 26, no. 5-6, pp. 578-599.
- Geerdink, B. (2006). "Critical IT systems in the value chain for successfully moving from mass production to mass customization", *4th Twente Conference on IT*, Enschede 30 January, 2006.
- Gilmore, J.H., and Pine II, B.J. (1997). "The Four Faces of Customization", *Harvard Business Review*, January-February, pp. 91-101.
- Grönroos, C. (2001). *Palveluiden johtaminen ja markkinointi*, (in Finnish, Management and marketing of services). WSOY, Helsinki.
- Hart, C.W. (1996). "Made to Order", *Marketing Management*, vol. 5, no. 2, pp. 10-23.
- Jiao, J., Ma, Q., and Tseng, M.M. (2003). "Towards high value-added products and services: mass customization and beyond", *Technovation*, vol. 23, no. 10, pp. 809-821.
- Jiao, J., and Tseng, M.M. (2004). "Customizability analysis in design for mass customization", *Computer-Aided Design*, vol. 36, no. 8, pp. 745-757..
- Kaplan, A.M., and Haenlein, M. (2006). "Toward a Parsimonious Definition of Traditional and Electronic Mass Customization", *Journal of Product Innovation Management*, vol. 23, no. 2, pp. 168-182.
- Kaappa- ja teollisuusministeriö (2006). *Huonekalujen valmistus*, (in Finnish, Manufacturing of furniture). Toimialabarometri, ennakkotiedot. Kaappa- ja teollisuusministeriö.

- Kekre, S. and Srinivasan, K. (1990). "Broader product line", *Management Science*, vol. 36, no. 10, pp.1216-1231.
- Laboratory of Virtual Technology (2006). Institute of Machine Design. Tampere University of Technology, <http://ruuvi.me.tut.fi/vrlab/vr.htm> (Permission to use the picture: Tapio Hellman 12.6.2006).
- Levenburg, N. M. and Klein, H. A. (2006). "Delivering Customer Services Online: Identifying Best Practices of Medium-Sized Enterprises", *Information Systems Journal*, vol. 16, pp.135-155.
- Lindman, M. (2005). *Tuotekehityskäytäntö huonekalualan yrityksissä. Raportti erityisesti suupohjalaisten huonekaluvalmistajien tuotekehitystoiminnan kehittämiseksi*, (in Finnish, Product development procedures in furniture companies. A report especially in the area of Suupohja to enhance product development operations of furniture manufacturers). Vaasan yliopisto, Vaasa, Finland.
- Lindman, M., and Peltoniemi, J. (2006). *Construction of Business Concepts. A Comparative Case Study of Design-Oriented Enterprises*. University of Vaasa, Vaasa, Finland.
- Luumala, H.T., and Lindman, M.T. (2006). "A Quasi-experimental Exploration of Consumers' Furniture Product Experiences in Different Store Environments", *Proceedings of the 35th EMAC-conference*, Athens, p. 7.
- MacCarthy, B., Brabazon, P.G., and Bramham, J. (2003). "Fundamental modes of operation for mass customization", *International Journal of Production Economics* 85, pp. 289-304.
- Piller, F.T. (2004). "Mass Customization: A short introduction and some myths of the concept", in *The First Finnish Mass Customization and Personalization Forum – Facing International Research*, (eds. Mäkipää, M., and Ruohonen, M.), e-Business Research Center, Research Reports 12, Tampere, pp. 1-14.
- Pine, B.J. (1993). *Mass Customization*. Harvard Business School Press, Boston.
- Pine, B.J., Victor, B., and Boynton, A. (1993). "Making mass customization work", *Harvard Business Review*, vol. 71, no. 5, pp. 108-117.
- Silveira, G., Borenstein, D., and Fogliatto, F. (2001). "Mass customization: Literature review and research directions", *International Journal of Production Economics*, vol. 72, no. 1, pp. 1-13.
- Takala-Schreib, V. (2000). *Suomi muotoilee – unelmien kuvajaisia diskurssien vallassa*, (in Finnish, Finland designs – reflection of dreams in power of discourse). Jyväskylä: Taideteollinen korkeakoulu, julkaisusarja A23.
- Toffler, A. (1971). *Future Shock*. Bantam Books, New York.
- Walsh, J., and Godfrey, S. (2000). "The internet: a new era in customer service", *European Management Journal*, no. 18, pp. 85-92.
- Zeithaml, V.A. (2002). "Service excellence in electronic channels", *Managing Service Quality*, no. 12, pp. 135-138.
- Zhou, L., Dai L., and Zhang, D. (2007). "Online Shopping Acceptance Model – A Critical Survey of Consumer Factors in Online Shopping", *Journal of Electronic Commerce Research*, vol. 8, no. 1, pp. 41-62.

Knowledge transfer across boundaries in e-learning, a solution proposal

Erkki Koponen

Seinäjoen ammattikorkeakoulu - Seinäjoki University of Applied Sciences

School of Information and Communication Technology

Kampusranta 9A

60320 Seinäjoki

Finland

Erkki.Koponen@seamk.fi

Abstract. E-learning is increasing as a means to enhance learning. However, e-learning is seen in research mainly narrowly from education perspective. Because the development and use of e-learning dispositions require pedagogical, organisational and ICT functions on individual, organisation and inter-organisation levels, knowledge transfer between various actor groups with different functional backgrounds can be seen problematic. Therefore, solution proposals for knowledge transfer across actor groups in e-learning context are required. We outline a framework for e-learning development and use and see it through the infrastructure as a social construction. Thereafter, for the knowledge transfer challenge across various actor groups we propose a solution as *“the e-learning community of knowing”*.

Keywords. E-learning, Infrastructure, Knowledge transfer, Community of knowing.

Introduction

In recent years the Internet has had dramatic impact on many knowledge intensive fields in industrialised societies. In education and especially in higher education learning via the Internet is increasing. The Internet eliminates distance between learners and teachers and gives travel cost savings compared to conventional classroom based learning. For the learners the Internet environment gives flexibility in learning.

The *e-learning* concept has recently become common among the literature related to learning in ICT environment. The notion “e-learning” includes the “e” part and the “learning” part. We see that in “learning” it is the question of transformation. Therefore, *in learning the initial state in the learner’s mind is transformed to the new state which is different from the initial state if learning has occurred* (Järvinen, 1999, 3; Aulin, 1982, 15). The “e” part in the notion of “e-learning” reflects the utilisation of ICT aiming to enhance the transformation between the initial and new state of learner’s mind, i.e. learning. Therefore, our definition of e-learning can be stated as follows.

E-learning is the utilisation of ICT in learning in order to acquire, store and process information as well as to develop these ICT utilisation abilities.

The utilisation of ICT in learning can be seen as the extension of human abilities. By utilising ICT the learner may regulate and manage existing ICT facilities by extending his/her own memory and the ability to process information, as well as communicate and transfer information with other learners. On higher level the learner may develop further these ICT facilities to enhance his/her abilities to manage the ICT use (Järvinen, 1999, 25). For the learner ICT offers new means to extend his/her learning sphere by utilising ICT in relation to the outside world and his/her own thinking. ICT environment comprises all the technical and informational dispositions which the learner may utilise in order to enhance learning. Learners may act in this ICT based learning environment and in relation to outside world, which comprise, e.g. an organisational and inter-organisational environments.

Recent research of e-learning has focused mainly on individual level and Education¹ leaving Information Systems¹ and larger organisational context nearly as a “black box” (Berge, 1995 in Tammelin, 2004) or e-learning is seen mainly from techno-economic perspective as Pulkkinen (2003) indicates. Utilisation of ICT in learning needs cooperation and knowledge transfer between pedagogical, ICT and administrative/managerial functions. However, knowledge transfer across various actor groups with different professional backgrounds may be problematic.

The aim of this study is to make a solution proposal for knowledge transfer across boundaries in e-learning development and use context seeing the e-learning phenomenon from holistic perspective in which the e-learning infrastructure is seen as a social construction (Star and Ruhleder, 1996). We first outline a holistic framework for e-learning. Thereafter, we analyse knowledge transfer across boundaries based on Carlile (2004), Star and Ruhleder (1996), and Davidson and Schofield (2001), and make a solution proposal for knowledge transfer across various actor groups with different functional backgrounds in e-learning development and use. We use technologists and teachers as an example.

¹ Capital letters in Education and Information Systems refer to sciences.

As a result, we outlined a holistic framework for the development and use of e-learning dispositions comprising individual and group, institute, as well as society levels in which pedagogy, community and social relations, organisation and its management, as well as ICT perspectives are included. Within this framework we made a solution proposal for the knowledge transfer challenge across boundaries as “*the e-learning community of knowing*”.

We first describe and analyse the notion of infrastructure as a social construction in the context of e-learning. Secondly, we apply this infrastructure in order to outline a holistic framework for e-learning. Thirdly, we analyse and describe solution proposals for knowledge transfer across boundaries in research literature and make our own proposal within our holistic framework for e-learning. Finally, we discuss of the results and implications for further research and practice.

Method of the study

The method of this study is prospective, goal oriented and therefore normative (how ought to be?). Also the method can be regarded as abductive. Furthermore, we try to see the research problem through various theoretical lenses (Giddens, 1984, 326).

According to van Aken (2005a) descriptive-driven research aims to be analytical, separating the components of a complex phenomenon being maybe partial focusing on some aspects of a whole. Prescriptive-driven research is field problem and solution oriented, describing and analysing alternative courses of action.

Actually, the notion prescription can be defined as an instruction to change the world (van Aken, 2004). The logic of algorithmic prescription is ‘if you want to achieve Y in situation Z then perform action X’. However, van Aken (2004) states that many prescriptions are heuristic in nature, i.e. ‘if you want to achieve Y in situation Z, then something like action X will help’, and then prescription is used as a design exemplar, which is a general prescription which has to be translated to the specific problem at hand by using a specific variant of that exemplar.

Van Aken (2005a) sees the prescriptive process models, i.e. tentative methods, as solution concepts which can be applied in various contexts by using creativity and expertise on a particular application area (van Aken, 2005b).

Pierce’s idea of abduction or hypothetic inference (Niiniluoto, 1984, 32-36) in applied form can be described as follows:

- (1) The surprising fact, C, is observed;
- (2) It is reasonable to suspect that some hypothesis of kind K explains C.
- (3) Hence, there is a reason to suspect that some hypothesis of kind K is true.

Niiniluoto (2007; 1984) states that Piercean abduction gives reasons for suggesting hypothesis as distinguished from reasons for accepting hypothesis. The

conclusion of abduction states that there are reasons for pursuing a hypothesis or finding a hypothesis testworthy. The ability of a hypothesis to give at least a potentially correct answer to a question, or to give potential explanation of the facts known so far, is an important part of the before-trial evaluation of a hypothesis. To make a hypothesis acceptable, it has to be put into tests.

The method of this study proceeds as follows. First, we describe infrastructure as a social construction according to Star and Ruhleder (1996) and see the e-learning phenomenon through this infrastructure. Secondly, we outline a holistic research framework for e-learning development and use according to the infrastructure as a social construction. Thirdly, because we see knowledge transfer within our holistic framework of e-learning as problematic, we describe solution proposals of Carlile (2004), Star and Ruhleder (1996), and Davidson and Schofield (2001) for the knowledge transfer problem. Fourthly, we analyse knowledge transfer across boundaries within our holistic research framework for e-learning, institutional groups of ICT technologists and teachers as an example. Finally, based on the analysis we make our solution proposal for challenges emerged in knowledge transfer across boundaries between technologists and teachers as an example. Based on the example we abductively think that the solution proposal might be regarded as a heuristic design exemplar. Also we think that the solution proposal as a tentative and hypothetical might be generalised also to concern some other actor groups in our framework, provided that the solution proposal will be tested by several practical cases which in this study are omitted.

E-learning infrastructure as a social construction

First we elaborate the e-learning development and use dispositions from a point of view of an infrastructure as a social construction.

In the national and local organisational contexts a common *infrastructure* of e-learning is required to assure a common action base for the development, administration, support, and use of the e-learning. Star and Ruhleder (1996)

“hold that infrastructure is a fundamentally relational concept. It becomes infrastructure in relation to organised practices ... and infrastructure emerges with the following dimensions:

- *Embeddedness*. Infrastructure is sunk into, inside of, other structures, social arrangements and technologies;
- *Transparency*. Infrastructure is transparent to use, in the sense that it does not have to be reinvented each time or assembled for each task, but invisibly supports those tasks;
- *Reach or scope*. This may be either spatial or temporal – infrastructure has reach beyond a single event or one-site practice;
- *Learned as part of membership*. The taken-for-grantedness of artifacts and organisational arrangements is a sine qua non of membership in a community of practice. Strangers and outsiders encounter infrastructure as a target object to be learned about. New participants acquire a naturalized familiarity with its objects as they become members;

- *Links with conventions of practice.* Infrastructure both shapes and is shaped by the conventions of a community of practice;...
- *Embodiment of standards.* Modified by scope and often by conflicting conventions, infrastructure takes on transparency by plugging into other infrastructures and tools in a standardised fashion;
- *Built on an installed base.* Infrastructure does not grow de novo; it wrestles with the 'inertia of the installed base';...
- *Becomes visible upon breakdown.* The normally invisible quality of working infrastructure becomes visible when it breaks. Even when there are back-up mechanisms or procedures, their existence further highlights the now-visible infrastructure."

From our point of view, concerning the infrastructure Star and Ruhleder (1996) pay attention to the tension between both local and global, and technical and social, and stresses the idea "when" is the infrastructure, not only "what" is the infrastructure. The "when" refers both to the slow developing process of the infrastructure and to the stability of it when it is reached. Therefore, the infrastructure according to Star and Ruhleder (1996) is a dynamically and continuously evolving structure. This infrastructure as a social construction differs from the conventionally understood infrastructure which refers to its rarely changing and stable features.

When the concepts e-learning environment and learning infrastructure are used, the concept environment is perceived more limited than infrastructure. Usually the e-learning environment refers to the technical and material environment and ignores the human and social aspects of the infrastructure, as well as the information resource, i.e. the learning content. According to the infrastructure of Star and Ruhleder (1996) we see that ICT can support the e-learning environment with both time and space dimensions, and global and local dimensions making the environment flexible for learners.

We separate the infrastructure of Star and Ruhleder (1996) from the formal organisation structure and speak of informal structure, i.e. communities of practice (Wenger, 1998) or networks of practice (Brown and Duguid, 2001). Informal structure leads us to think of context, i.e. a particular changing practice situation, in which routines and practices are agreed informally.

Furthermore, the organisation is only one level when the infrastructure in the sense of Star and Ruhleder (1996) is concerned. The infrastructure reaches from society level to organisation, group, and individual levels comprising not only material environments, e.g. ICT technology with physical networks, hardware, software, and information sources, but also all the immaterial organisational, social, and individual dispositions with attitudes, cultures as well as cognitive and affective properties.

From the resource perspective the learning environment can be seen as flexible learning dispositions comprising physical, human and informational resources (Järvinen, 2000, 12) exploited by learners dynamically in flexible manner within the flexible learning infrastructure in which these dispositions are embedded.

From actor perspective we interpret the learning infrastructure so that it is developed, created, and maintained by various parties who are collaboratively responsible for the external learning dispositions enabling the internal flexible and dynamic dispositions of the learning environment, i.e. actors on international, society, institute, and group, as well as individual level. On society- and inter-society level, actors are responsible for to develop, create, and maintain knowledge society strategies, resources, and administration in learning dispositions, as well as the international scientific research community responsible for the research of e-learning. On institute level, actors are responsible for to develop and create intra- and inter-organisational learning dispositions, i.e. institutionalised norms, legitimate habits and values as well as human, technological and informational resources which enable learning environment for group and individual level. On group level, actors are responsible for attitudes and abilities in social and collaborative relations referring to learning dispositions including studying, teaching, organising, administrating, and supporting. On individual level, actors are responsible for cognitive and affective level attitudes and abilities referring to learning dispositions, i.e. studying, teaching, organising, administrating, and supporting. The levels developing, creating, and maintaining the learning infrastructure are not separate actors, but interrelated impacting and be impacted on each other.

Because the national and local e-learning environments are relatively new learning dispositions, all the eight dimensions (Star and Ruhleder, 1996) for the success of the common learning infrastructure implementation are required. The e-learning may act in the environment of the Internet with various technical platforms, in the context of appropriate educational systems, and in the communities and networks of practice. The national e-learning environment widely extends to numerous organisations and should not disturb the individual learning event on the contrary e-learning environment should support it. The e-learning tools and organisational habits, as well as new ways to teach and study have to be learned as a part of the e-learning community of practice and the conventions of the e-learning community and the community of practice itself should be shaped in an enacting and reflective way within the infrastructure. The e-learning environment with all the tools and social structures which facilitate e-learning, as well as for the e-learning appropriate teaching and studying styles which may conflict with the conventional ones include to the learning infrastructure. But the infrastructure is able to be built slowly on the formerly learned and institutionalised practice base, e.g. individual and organisation level conventional studying and teaching styles and computer usage, as well as other conventional organisational and individual practices. Only exceptionally, when something goes wrong, the infrastructure should become visible. Consequently, we regard the infrastructure of Star and Ruhleder (1996) as the base of our holistic research framework for e-learning.

A holistic research framework for e-learning

Next we outline our research framework which is based on the notion of infrastructure as a social construction (Star and Ruhleder, 1996).

The learning infrastructure including various e-learning environments can be seen from four partly overlapping pedagogical, social, managerial and technical perspectives. Tammelin (2004, 69 referring to Berge 1995, 24) has seen these perspectives as teacher roles in the e-learning environment, but we see these perspectives from the view point of the development and use of the e-learning dispositions. We see the e-learning perspectives *pedagogy, community with social relations, organisation and its management, and technology*, as overlapped and intertwined, building the e-learning environment within the spatial and temporal learning infrastructure. The four perspectives are considered on course, institute and society levels (Table 1).

In the pedagogical perspective it is a question of learning models. In the social perspective the communality with various social reciprocal interrelationships in the context of learning are concerned. In the organisational perspective administrative functions on various levels of the learning infrastructure are important, i.e. the course organising and administration, institute level cultures and norms for the course implementation, and the society level inter-organisational administration, e.g. the virtual university. From technical perspective the physical and material e-learning environment with hardware, software, e-learning platforms, and various standards facilitating e-learning, as well as human function with knowledge and skills, are required in various learning contexts. On each perspective and level the information viewpoint with learning contents, various databases with learning materials, participant lists, etc., as well as managerial and process information have also to be taken into account.

ICT can be seen as an extension of human abilities, i.e. memory, communication and information processing. These abilities learner may use and enhance further. For instance, by searching information from the Internet the learner may select the search method and search engine, to collect, sort, and store information for further use. Also the learner may apply and develop further these search methods and facilities to enhance his/her own ICT utilisation abilities. Therefore, on individual and group levels ICT may enhance possibilities to utilise ICT in learning, but the utilisation of ICT needs to be organised, managed and developed on individual and group levels. Pedagogy and learning theories may be on the background of the ICT utilisation, e.g. constructivism. Institute level enables or constrains ICT utilisation in learning on individual and group level and society level enables or constrains institute level.

In the e-learning context there are many actors aiming to enhance learning, e.g. teachers, learners, technologists, and administrators on course, institute as well as society level. Each actor has his/her own and distinct physical/technical, social, and informational (data/knowledge) environment according to the resource types, i.e. physical, human, financial, and informational resources (Järvinen, 2000, 12). In Järvinen's classification the financial resource can be used to buy the other three resources. On the other hand, the environments establish common developing and learning communities on course, institute and society levels. Therefore, also from a resource point of view pedagogy, community, organisation and ICT, on course, institute and society levels are important. Hence the resource view, not depicted in Table 1, will also become to be taken into account in the holistic e-learning framework.

Table 1. Perspectives of e-learning on various levels of analysis.

Perspectives of e-learning	Levels of analysis		
	Course	Institute	Society
Pedagogy with learning theories and models			
Community and social relations with learning related social theories and models			
Organisation and its management with learning related organisation theories			
Information and communication technology in relation to learning theories			

On the course level the individual learner, teacher, and technologist, as well as, group activities of the actors mentioned, with various managerial and technical facilities are emphasised. On the institute level the ICT related learning cultures, resource management, curriculum and its development, institutional norms and standards, inter-unit activities within the institution, and the institution level ICT facility development and management, are focused. On the society level the strategies of the national education, the strategies of communality between institutes, the financial and other resources for the institute level communality, for instance, in the form of network based virtual university and e-learning centres, as well as the strategy of the national technology policy including e-learning facilitation, are emphasised.

On each level management and operating feedback loops (Kerola and Järvinen, 1975, 43) emerge. On management level planning gives instructions to

operation level performance which in turn produce control information back to the management level. Management, i.e. coordination comprises the planning and control of all resources in order to attain stated objectives (Sisk, 1973, 13 in Järvinen, 2000, 11). The operation phase includes the implementation of the tasks or activities concerned. From the e-learning dispositions development point of view it is vital to find out the critical points of the connections between course, institute, and society levels. Which connections are “sticky” and which are “leaky”? If we use other metaphorical expressions, which actions, on the one hand, enable, facilitate, or make fluid, on the other hand, constrain, frustrate, or make clumsy, the interaction between pedagogy, communality, management and ICT on course, institute and society levels. For example, the technical ICT network connections or channels function or not or they are open or full booked. In addition the management relations between various levels have to be appropriate, i.e. the institute level manages courses and the society manages institutes. Also in human relation connections challenges may occur if knowledge and knowing on various levels are different or knowledge or knowing required on particular level omits. For instance, on institute level the course administration knowledge does not fit with the course level administrative knowledge and knowing, making the knowledge transfer across the boundary sticky or even impossible disadvantaging or preventing the coordination between the levels.

Hence, we conclude that the e-learning infrastructure comprises the intertwined network of the learning dispositions in which *pedagogy, community with social relations, organisation and its management, and ICT technology* all on individual, group, institute, and society levels. In this intertwined network various relationships on the one hand, impact and shape, on the other hand, are impacted and shaped each other comprising a holistic e-learning infrastructure. Vital is how actors in this network can work together in the development and use of e-learning and produce joint practices and shared knowledge in a communal and collaborative way, the focal object of which is to make a learner to learn. Therefore, we next elaborate knowledge transfer and cooperation problem across the boundaries within our holistic framework of e-learning and make a solution proposal to overcome challenges emerged.

A solution proposal for knowledge transfer across boundaries

In this section we first describe the problem situation and solution proposals of knowledge transfer across boundaries according to Carlile’s (2004) framework, Bateson’s (1978) communication model applied by Star and Ruhleder (1996), as well as the longitudinal case of Davidson and Schofield (2001). Secondly, we analyse knowledge transfer across boundaries between technologists and teachers, as an example in our holistic framework for e-learning. Finally, we make our solution proposal for the knowledge transfer across boundaries within our holistic framework of e-learning.

Carlile's solution proposal

According to our holistic research framework (Table 1) the e-learning phenomenon can be regarded as knowledge intensive and complex in nature with all dynamic and intertwined interrelationships among pedagogy, community, management and ICT on course, institute and society levels. Particularly the boundaries on the one hand, between pedagogy, community, management and ICT, on the other hand, between the course, institute and society levels, make the communication and cooperation among these entities complex. Carlile (2004) propose an integrative framework for managing knowledge across this kind of boundaries. According to Carlile's framework in order to manage knowledge transfer across boundaries syntactic knowledge transfer, semantic knowledge translation, and pragmatic knowledge transformation are required.

Syntactic knowledge transfer (information processing approach) needs a common lexicon for differences and dependences including knowledge to be successfully shared and assessed at a boundary. Storage and retrieval technologies with syntactic capacity and taxonomies are used. The challenge may be the need of increasing capacity to process information. Also the change of the stable conditions may cause a challenge. Therefore, "a common lexicon is necessary but not always sufficient to share and assess knowledge across boundaries."

Semantic knowledge translation (interpretive approach) needs to develop a common meaning for the novel knowledge with unclear differences and dependencies. In this explanation process semantic capacity and cross-functional interactions and themes or boundary translators, i.e. brokers, are needed. Therefore, "to create common meanings to share and assess knowledge often requires creating new agreements." The challenge is how common meanings could be attained about tacit knowing.

Pragmatic knowledge transformation (political approach) needs to develop common interests for the novel knowledge with different interests between actors on different sides of the boundary. The transformation process needs pragmatic capacity, prototyping and other kinds of boundary objects which can be jointly transformed. Therefore, "to create common interests to share and assess knowledge requires significant practical and political efforts." The changing knowledge is the challenge.

Carlile's theory base for the solution proposal in syntactic knowledge transfer is information processing, for semantic knowledge translation as learning (e.g. communities of practice by Lave and Wenger, 1991) or creating shared meanings (e.g. Nonaka, 1994), and for pragmatic knowledge transformation "creative abrasion" (Leonard-Barton 1992) or negotiating practice (Brown and Duguid, 2001).

We see that Carlile's framework well shows the complexity of the e-learning dispositions and the knowledge management within our framework. Carlile's framework also shows that the challenges of knowledge transfer across boundaries are subject to be solved.

Star and Ruhleder's solution proposal

In Carlile's view, the solution for the syntactic boundary as an information processing with common lexicon may cause challenge when stable conditions change and cause exceptional condition. On semantic and pragmatic boundaries we see a challenge how to solve Bateson's (1978) "double bind" in communication between two various contexts with participants' various social meanings of the technology causing "infrastructural transcontextual syndrome".

Star and Ruhleder (1996) use Bateson's (1978) model for understanding the ways in which communicative processes are entangled in the development of infrastructure, i.e. how communicative problems emerge and can be solved, for instance in our case, in the development and use of e-learning dispositions between technologists and teachers with various skill and knowledge backgrounds. Bateson's communication model includes three levels. At the first level are straightforward "fact" statements. The second order statement tells something about the reliability of the first order statement, i.e. the facts, and a gulf between context and message exists. The third order statement exposes the range of possibilities and also conflicting approaches when evaluating the contexts in which the second order statement, i.e. the facts, exists. Double binds between the three levels may emerge. For instance there is a first and second order difference in learning something and learning about learning something. Between the second and third order statements there are even more abstract differences between learning to learn, and learning about theories of learning.

Star and Ruhleder (1996) reported two means to solve double bind problems in IT based development project. First, they propose to establish a multi-disciplinary working team. Within a team developers and users should learn common professional language. Secondly, users should study IT skills so that they could apply their skills also in future IT applications. Studying could be implemented during a longer period of time based on continuous interaction and use experiences. Also local, grass root level brokers in guidance have to be accepted.

Davidson and Schofield's solution proposal

Bateson's three levels can be seen for instance in the longitudinal case study of Davidson and Schofield (2001) who described interpersonal interactions between technical staff and teachers. Technical staff and teachers had obstacles in their cooperation. First, technical staff was able to work flexibly and could change their working priorities, times and styles. Teachers work was structured, routine, and fixed by schedules. Secondly, the values of the technical staff were techno-centric and they were interested in new features of new technical products and systems. Teachers emphasised pragmatic issues in their work, e.g. tested learning methods, to attain from outside given learning targets. Thirdly, the attitudes to technology were different. The technical staff regarded technological artefacts as instruments to play with and experiment all new. The teachers regarded technical systems as tools for something useful. We think that

similar differences may emerge between administrative and teaching staff as well as administrative and technical staff on institute and individual level when ICT in learning is utilised. Referring to three levels of Bateson's communication model in the case of Davidson and Schofield (2001) the first order issue could have been solved straightforward by furnishing the new ICT based learning system. The second order issues emerge when technical and teaching staffs with their original working norms and values on background come to the common context, i.e. to develop or use the e-learning dispositions, in which technical and teaching staffs have to communicate and try to cooperate. The third order issues emerge when cooperation between technical and teaching staffs begin and various interpretations of the development and use possibilities and possible contradictory views are articulated.

Davidson and Schofield (2001) reported from their case that for the solution of the conflict the new technical staff was hired as a broker between teachers and technologists.

Our solution proposal

Our analysis and solution proposal of knowledge transfer across boundaries support and supplement the findings of Carlile (2004), Star and Ruhleder (1996), and Davidson and Schofield (2001). In each three solution proposals there are some *brokering* efforts to bridge the boundary. Our solution proposal is mainly based on Boland and Tenkasi's (1995) perspective making and perspective taking, and on Cook and Brown's (1999) "generative dance" between explicit knowledge and tacit knowing on individual and group levels. Our idea is to *assimilate* the broker tasks into a community of knowing. We describe the ideas of Boland and Tenkasi, and Cook and Brown, and apply the ideas to the example of knowledge transfer between technologists and teachers. Finally, we generalise the solution proposal of the example within our holistic framework for e-learning.

The view of Boland and Tenkasi

By following the idea of *perspective making and perspective taking* (Boland and Tenkasi, 1995) two expert groups with various professional backgrounds, aiming to cooperate form a group called "*community of knowing*". *Perspective making* is the process whereby a community of knowing develops and strengthens its own knowledge domain and practices. As perspective strengthens, it becomes more complex and therefore better able to do knowledge work by using language games in a social practice. In *perspective taking* the knowing of what others know is a necessary component for coordinated action. The diverse knowledge held by individuals in the organisation must be represented in its uniqueness, and made available for others to incorporate it in a perspective taking process which includes a variety of inferential and judgmental processes. Boland and Tenkasi (1995) argue that producing knowledge requires the ability to make strong perspectives within a community, as well as the ability to take the

perspective of another into account. Knowledge work of perspective making and perspective taking requires individual cognition (narratives and information processing) and group communication (language game and conduit). As we recognise unusual or unexpected events, narratives make sense of them and support more precise information processing. The *boundary objects*, the concepts belonging to the expertise domain of both professionals, play an important role in cooperation.

If we think the division of labour (Järvinen, 1980), some *non-productive additional tasks* (inspections, transportation, communication and coordination) emerge. These additional tasks might be *assimilated* into a new community of knowing (Boland and Tenkasi, 1995) by joining the broker bridge (Barley, 1996) to this community. As a consequence, the idea of Boland and Tenkasi encourages team work of experts with various professional backgrounds.

The view of Cook and Brown

In the idea of Cook and Brown (1999) explicit narratives and language game of Boland and Tenkasi are supplemented by tacit knowing in the form of bridging epistemologies of possession and practice (Figure 1).

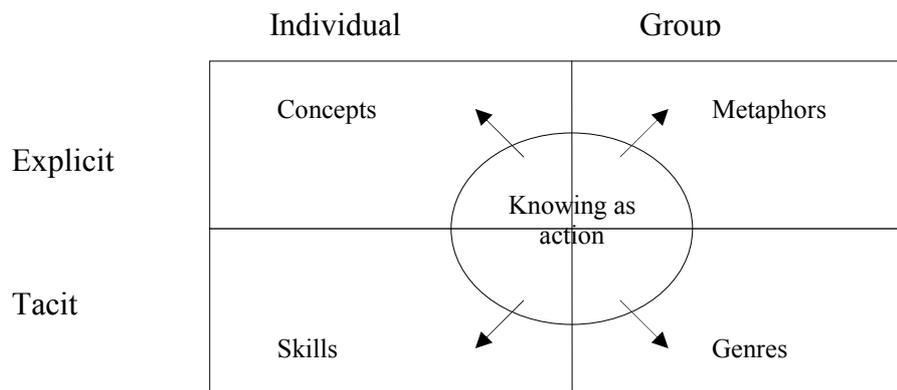


Figure 1. Bridging epistemologies of possession and practice (Cook and Brown, 1999).

The metaphor “*generative dance*” means to bridging epistemologies of possession, i.e. knowledge possessed in individual’s mind, and epistemologies of practice in which, on the one hand individual and group levels, on the other hand, explicit and tacit dimensions of knowledge and knowing are concerned. For individuals explicit knowledge means concepts, for group metaphorical stories. Tacit knowing for individuals means skills, for group genres, i.e. joint understanding of the shared meanings of individual group members’ own meanings of the perceptions of the interaction with the world. The genre dynamically affords a generative dance within which the creation of new knowledge and new ways of using knowledge are possible. Knowing entails the use of knowledge as a tool in the interaction with the world. This interaction, in turn, is a bridge which links knowledge and knowing. And bridging epistemologies makes possible the generative dance, which is the source of

innovation, and which constitutes the ability to generate new knowledge and new ways of using knowledge, which knowledge alone cannot do.

We conclude that knowledge transfer across boundaries in the idea of Cook and Brown (1999) is condensed inside a working team in which explicit knowledge and tacit knowing interact during everyday practice gradually enabling the genre.

An example of knowledge transfer between technologists and teachers

In our holistic framework of e-learning for instance education oriented teachers and ICT oriented technologists are intended to cooperate and transfer knowledge when the development and use of e-learning are concerned. Therefore, pedagogical and ICT perspectives encounter on individual, institute and inter-institute levels. This encounter is social and needs to be organised and managed when technologists and teachers as institutional and inter-institutional working groups are concerned. Hence, all the perspectives on individual and institute levels within our holistic research framework for e-learning are important and have to be noticed.

In the context of e-learning the technologist, on the one hand, and the teacher, on the other hand, stands on the frontier of the technological and learning expertise. For instance, non-productive tasks as continuous technological guidance and technological problem solving are needed when teachers utilise ICT in their work. Teachers explain their ICT problems to technologists by using their own professional language and technologists explain the solutions to the problems by using their own professional language. The *assimilation* of the technologists' and learning experts' expertise and skills may solve Bateson's (1978) double binds in communication between two contexts. In the sense of Boland and Tenkasi (1995) learning experts have to learn technology and technology experts have to learn how to learn. Also the technologists and teachers have to learn each other's professional languages. The assimilation becomes tighter when learning occurs in a real and joint working context of a unified expertise community. However, the assimilation of the technology and learning expertise into the community of knowing is an evolutionary process which needs joint training, developing, and cooperation of technologists and learning experts and also grass root level brokering in the real everyday working context as Star and Ruhleder (1996) described in their solution proposal. Hence, brokering of the technology (Barley, 1996) and learning is needed in the form of *learning technologists* whose expertise covers both pedagogical and ICT skills.

Therefore, we think that one promising aid to assimilate the expertise of technology and learning into "*e-learning community of knowing*" is a joint e-learning developing project among technology and teaching staffs interested in e-learning. On the one hand, the e-learning course developing groups could be created among teaching and ICT staffs, learning technologists as brokers, within and between education institutes, in order to assure as wide expertise as possible. On the other hand, the developing groups could be made as cohesive as possible by assimilating participants' working practices in order to assure the performance of the developing work within the group. The both objectives at the same time are

not easy to achieve, and require the creation of the communities and networks of practice (Lave and Wenger, 1990; Brown and Duguid, 2001) which can be developed towards e-learning community of knowing. The adapting and adoption of even strange practices, professional languages, and acting cultures within the developing group the “infrastructural transcontextual syndrome” (Star and Ruhleder, 1996) may be avoided. The adapting and adoption of joint practices need changing of the attitudes from bare individual and cognitive acting to cooperative and communal acting. But in order to attain the e-learning community of knowing the expertise of technologists, teachers and other learning supportive staff should be joint and shared in communal and reflective way. However, in the community’s reflection process contradictions and conflicts have to be tolerated.

The members of the e-learning developing and use group, comprised by technologists and teachers, have their individual knowledge and skill base referring to the developing and use practice of ICT. As Davidson and Schofield (2001) described in their case technical staff’s work conditions were flexible and values techno-centric, whereas teachers’ work were structured and fixed, and they emphasised pragmatic issues in their work related to ICT. Various perspectives in the group provoke different ways of assessing what is known and how to act in practice. Through productive inquiry (Cook and Brown, 1999), among the e-learning developing group, technologists and teachers deliberately, both consciously and unconsciously, seeking the way of practice, for instance by explaining the meaning of ICT terms on the one hand, and pedagogical ideas on the other hand to each other bridging Carlile’s (2004) semantic knowledge boundary. Also pragmatic knowledge boundaries between technologists and teachers may emerge for instance in hegemony between technology and pedagogy cultures. For example, in the notion of “e-learning” the predominant Internet culture may make the “learning” less significant than “e” and this cultural feature may emerge on individual, group, institute, and society levels. On the other hand, teachers and other learning experts may regard the notion “e” only as a conventional book stored in digital form omitting for instance the processing and communication power of ICT in e-learning. This kind of pragmatic knowledge boundaries which reside in beliefs and values of individuals, have to be bridged.

When technologists and teachers by conversation negotiate a joint understanding what “doing it this way” really means, the practice is generative and source of innovation (Cook and Brown, 1999).

For instance, when semantic knowledge (Charlile, 2004) is concerned teachers may understand that when technologists explain that they update or even change the technical e-learning platform, it may become more complex, but also it may give more opportunities to develop and use the platform pedagogically. A teacher may meet a challenge to study more about technical e-learning platform. On the other hand, similarly technologists may understand for instance teachers’ demand for technologists to develop a new multimedia based learning object which may enhance e-learning pedagogically. A technologist may meet a challenge to learn more about pedagogical usability of that multimedia learning object. This kind of standing to each other’s professional area may advance mutual understanding, despite of the misunderstandings which may cause temporary contradictions.

For instance, contradictions may emerge who is in responsible for updating a reusable learning content from the old technical learning platform to new one. When no agreement between technologists and teachers of the task exist, the mutual understanding has to be found by practical efforts. For instance, a new informal updating agreement is required between technologists and teachers which take into account both parties' knowledge and skill needs by reflecting and working together to complete the common task. The common meaning of the new informal working agreement and common interest to share knowledge within it may constitute the genre for the group in which the genre dynamically affords the creation of new knowledge and new ways of using knowledge.

When pragmatic knowledge (Charlile, 2004) is concerned, de facto standardised global Internet and wide adoption of the Internet culture, e.g. among education institutes, may encourage teachers to change their attitudes from conventional classroom based teaching towards ICT utilisation in learning. On the other hand, from technologists' point of view the Internet de facto standards enable to develop and use various technical e-learning platforms which can be exploited widely, both nationally and internationally, in the e-learning development and use. Therefore, technologists' willingness to develop for instance multimedia based learning objects or learning platforms may increase because of their wide usability. Hence, the Internet as a global ICT innovation may give opportunities and motivation to technologists and teachers to endeavour joint understanding in the e-learning development and use.

As the conclusion, we proposed a solution for knowledge transfer across boundaries, technologists and teachers as an example. The solution proposal is the e-learning community of knowing which is mainly based on theories of Boland and Tenkasi (1995), and Cook and Brown (1999). We think that the e-learning community of knowing might be generalised to include also other interested parties than technologists and teachers in our holistic framework for e-learning, i.e. students, administrators, and managers. The e-learning community of knowing might also be extended from group level to institute and inter-institute levels on which multi-disciplinary and multi-national developing groups could be formed. To attain joint understanding becomes more complex in extended developing groups compared to the groups comprising only technologists and teachers. General demand for the globalisation of learning particularly in higher education institutes makes knowledge transfer across organisational boundaries challenging, because of, for instance, cultural reasons. However, based on our solution proposal, we have reason to suspect that also global e-learning communities of knowing might be possible to be tried in practice and they might have opportunities to succeed.

Discussion

In order to make a solution proposal for knowledge transfer across boundaries when the e-learning development and use dispositions are concerned, we first outlined

a holistic framework for the e-learning development and use (Table1) in which pedagogy with learning models, community and social relations, organisation and its management, as well as ICT dispositions and its utilisation are concerned on individual, group, organisation and inter-organisation levels.

Secondly, we made

a solution proposal as “the e-learning community of knowing” to overcome challenges in knowledge sharing across boundaries within our holistic framework for e-learning .

Our framework extends Tammelin’s (2004, 69 referring to Berge 1995, 24) framework in which the e-learning is seen only from learner and teacher role perspectives and mainly omits the ICT as a “black box”.

The holistic view of the e-learning phenomenon includes advantages, but also deficiencies. The advantage is to see the general view of the intertwined network of pedagogy, social relations, organisation and ICT on individual, group, institute and society levels. Also the complexity of the relationships is seen as a whole, i.e. the role of ICT, social relations and their management on individual, group and institute levels. The main deficiency of the holistic view is that we cannot see the details of the relationships. Because of the importance of the knowledge transfer across boundaries between various interested parties within the framework, the knowledge transfer is analysed more closely and a solution proposed. The solution proposal is based on an example of knowledge transfer between technologists and teachers and abductively generalised also to other interested parties in the framework.

We think that our solution proposal supplements the solution proposals of Carlile (2004), Star and Ruhleder (1996), and Davidson and Schofield (2001). Our analysis and solution proposal is mainly based on the idea of perspective making and perspective taking (Boland and Tenkasi, 1995), and the knowledge creation process on the idea of bridging epistemologies of possession and practice (Cook and Brown, 1999) assimilating the brokering function between various actor groups into the e-learning community of knowing. The solution proposal is normative, because it endeavours to a desired goal, i.e. to joint understanding within the e-learning developing group. Based on the example of knowledge transfer between technologists and teachers we abductively conclude that our solution proposal as a hypothesis might be testworthy. Therefore, it is necessary to test the solution proposal by using several practical cases which in this study are omitted.

On organisational level our solution proposal supports for instance Leidner and Kayworth (2006) who indicate that IT may have an opportunity to change organisation culture. To endeavour joint understanding of ICT utilisation in learning, for instance between technologists and teachers, attitudes and finally organisation culture may gradually change from closed subcultures, e.g. technologists’ and teachers’ subcultures, toward more open ICT culture in which

ICT is seen, on the one hand, facilitating, on the other hand, transparent force in learning. In this kind of slow cultural transformation process toward a new learning culture in which ICT is a driving force conflicts will undoubtedly emerge among individuals from different social groups with overlapping and shifting interests in differentiated work organisations (Kling, 1980), and the conflicts has to be resolute.

Our answer to this resolution is the e-learning community of knowing. We think that the final target might be the *e-learning community of inquiry*, based on Eikeland's (2006) learning community of inquiry. In the e-learning community of inquiry learners, teachers, ICT and administrative staff could work together by applying *action research method* in order to develop the e-learning dispositions. The action research method in this context might be seen to belong to design science as a participatory activity (Niiniluoto, 1993; Järvinen, 2007). Also we see that the e-learning community of inquiry might be regarded as a design exemplar and a tentative solution concept (van Aken, 2004) for the development and use of e-learning dispositions. In practice according to our holistic framework the e-learning community of inquiry might be tried as a scientific problem solving project (Niiniluoto, 1993) in coming e-learning development projects.

References

- Aulin, A. (1982). *The cybernetic laws of social progress*. Oxford: Pergamon Press.
- Barley, S. R. (1996). *Technicians in the workplace: Ethnographic evidence for bringing work into organisation studies*. Administrative Science Quarterly 41, No 3, 404-441.
- Bateson, G. (1972). *Steps to ecology of mind*. Ninth printing 1981, New York: Ballantine Books.
- Berge, Z. L. (1995). *Facilitating computer conferencing*. Recommendations from the field.
- Boland, R. J. and Tenkasi, R. V. (1995). *Perspective making and perspective taking in communities of knowing*. Organisation Science 6, No 4, 350-372.
- Brown, J.S., and Duguid P. (2001). *Knowledge and organisation: A social-practice perspective*. Organisation Science 12, No 2, 198 - 213.
- Carlile, P. R. (2004). *Transferring, translating and transforming: an integrative framework for managing knowledge across boundaries*. Organisation Science 15, No 5, 555-568.
- Cook, D. and Brown, J. S. (1999). *Bridging epistemologies: The generative dance between organisational knowledge and organisational knowing*. Organisation Science 10, No 4, 381-400.
- Davidson, A. L. and Schofield, J. (2001). *Professional cultures and collaborative efforts: A case study of technologists and educators working for change*. The Information Society, 17, 21-32.
- Eikeland, O. (2006). *Condescending ethics and action research*. Extended review article, Action Research 4, No 1, 37-47.
- Giddens, A. (1984). *The constitution of society*. Cambridge: Polity Press.
- Järvinen P. (1980). *On structuring problems of job design met in the development and maintenance of information systems*. BIT 20, 15 - 24.
- Järvinen, P. (1999). *Oman työn analyysi ja kehittäminen*. Tampere: Opinpaja Oy.
- Järvinen, P. (2000). *Atk-toiminnan johtaminen*. Tampere: Opinpajan kirja.
- Järvinen, P. (2007). *Action research is similar to design science*. Quality and Quantity, 41, 37-54.
- Kerola, P ja Järvinen, P (1975). *Systemointi II*. Helsinki: Oy Gaudeamus Ab.

- Kling, R. (1980). *Social analysis of computing: Theoretical perspectives in recent empirical studies*. ACM Computing Surveys 12, No 1, 61-110.
- Lave J. and Wenger E. (1990). *Situated learning: Legitimate peripheral participation*. IRL report 90-0013, Paolo Alto, CA:Institute for Research on Learning, Cambridge: Cambridge Univ. Press.
- Leidner, D. E. and Kayworth, T. (2006). *A review of culture in information systems research: Toward a theory of information technology culture conflict*. MIS Quarterly 30 No 2, 357-399.
- Leonard-Barton, D. (1992). *Core capabilities and core rigidities: A paradox in managing new product development*. Strategic Management Journal 13, 111-126.
- Niiniluoto, I. (1984). *Is science progressive?* Dordrecht: D. Reidel.
- Niiniluoto, I. (2007). *Defending abduction*. Unpublished, Department of Philosophy, University of Helsinki, <http://scistud.umk.edu/psa98/papers/niiniluoto.pdf> [14.1.2007].
- Niiniluoto, I. (1993). *The aim and structure of applied science*. Erkenntnis, 38, 1-21.
- Nonaka, I. (1994). *A dynamic theory of organisational knowledge creation*. Organisation Science 5, No 1, 14 - 37.
- Pulkkinen, J. (2003). *The paradigms of e-education, an analysis of the communication structures in the research on information and communication technology integration in education in the years 2000 – 2001*. Academic dissertation, Faculty of Education, University of Oulu, Department of Educational Sciences and Teacher Education. <http://herkules oulu.fi/isbn9514272463/html/index.html>. [27.8.2005]
- Sisk H. L. (1973). *Management and organisation*. Cincinnati: South-Western Pub.
- Star, S.L. and Ruhleder, K. (1996). *Steps toward ecology of infrastructure: Design and access for large information spaces*. Information Systems Research 7, No 1, 111-134.
- Tammelin, M. (2004). *Introducing a Collaborative Network Based Learning Environment into the Foreign Language and Business Communication Teaching, Action Research in Finnish Higher Education*. Academic Dissertation, Faculty of Behavioural Sciences in the University of Helsinki, at the Department of Applied Sciences of Education, Media Education Publications 11.
- Van Aken, J. E. (2004). *Management research based on the paradigms of the design sciences: The quest for field-tested and grounded technological rules*. Journal of Management studies 41, No 2, 220 – 246.
- Van Aken, J. E. (2005a). *Valid knowledge for the professional design of large and complex design processes*. Design Studies 26, 379 – 404, <http://www.elsevier.com/locate/destud>.
- Van Aken, J. E. (2005b). *The nature of organisation design: much like material object design, but very unlike in its working*. manuscript (17 Sep 05) submitted to Organisation Science, version 17 Sep 05.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Was it Pod Worthy?

Anna Wingkvist
Växjö University, Sweden
anna.wingkvist@vxu.se

Jason Alexander
University of Canterbury, New Zealand
jason@cosc.canterbury.ac.nz

Abstract. Students and teaching staff in higher education are constantly looking for new tools to help them study and teach more efficiently. The University of Canterbury began ProjectPodcast to introduce podcasting to a number of subjects as an add-on to the current course curriculum. Podcasting is being used to enhance mobile learning and enthuse both students and lecturers. Previous podcasting evaluations show that there exists a need for both audio content from lectures, or so called “LectureCasts” as well as supplementary material or “Sup!Casts”. In this study, the evaluation of ProjectPodcast will be performed in-house. We have chosen an established six step methodology to avoid criticisms that often arise when evaluations are performed by internal members of the project. The evaluation is aimed at both the student population as well as the lecturing staff in order to gain knowledge about their impressions of podcasting. Prior podcasting surveys have received low response rates, due to the choice of time, location and medium. Hence, our evaluation plan has been created with the goal of encouraging feedback from students and lecturers. In this paper we present our preparatory plan for evaluating ProjectPodcast.

Keywords. Podcasting, higher education, evaluation, educational technology, mobility

1 Introduction

The current generation of students in higher education are rapid adopters of new technology, with lecturers always looking for new and exciting methods to encourage students to continue their studies outside the classroom. Podcasting is seen as an innovative way to engage students in their course work. The simple act of utilising technology as part of their learning is often seen as a more attractive

option to students than the thought of sitting down to read course material. Several universities have recognised this fact and are now producing their own podcasts to aid students in their studies.

Podcasts are multimedia files, usually in the mp3 format, that are distributed by subscription to an RSS-feed, allowing downloads to be ‘pushed’ onto digital playback devices. Some universities are providing audio content of lectures, while others are producing supplementary material, with the hope of stimulating interest in the subject area. By nature, podcasts are informal recordings often made in one continuous session with little or no editing done before release. However, the addition of introductory and/or background music gives a more professional feel to the podcasts. Despite often large audiences, inducing feedback from listeners is one of the most difficult tasks for podcast creators. This is especially important in the educational situation, where teaching staff need to know whether their efforts are being wasted on producing podcasts or whether the material covered could be adjusted to further benefit student’s learning. There has also become an ever increasing need to convince management that time and money is being spent appropriately. The best way to provide evidence of the worthiness of a concept is through evaluation.

This paper describes the preparatory planning for evaluating ProjectPodcast—an initiative at the University of Canterbury to encourage lecturers from a variety of departments (including Computer Science, Economics, Japanese, Music and Education) to provide podcasts for their courses. We firstly give examples of how podcasts are currently used in higher education and then consider evaluations of podcasting that have already been conducted and the shortcomings of these. We then describe our preparatory planning for the creation of the ProjectPodcast evaluation. The evaluation includes both the student population and the teaching staff who are producing the podcasts. We also discuss our thoughts on how to encourage participation, especially from the students involved in the project.

2 Podcasts in Higher Education

Lecturers are often keen to embrace any new technology that will aid them in teaching or helping their students to learn. Podcasting is a technology that has proven itself on the Internet, and has now caught the attention of universities. What makes podcasting especially attractive is the large percentage of students who already own portable media devices combined with the numerous opportunities for listening (e.g. commuting, exercising, doing household chores).

Universities have taken two different paths in providing podcasts for their students. The first is to provide the recordings of the lectures, allowing those who miss all or part of them to catch-up. We call these “LectureCasts”. The second is to produce podcasts containing supplementary material to that given in lectures, labs or tutorials, which may or may not form part of the examinable course

content. These we call “Sup!Casts”, this nomenclature derives from two sources: “supplementary” and from the colloquial abbreviation of “What’s Up?”—“Sup?”. The question mark is replaced with an exclamation mark in recognition of podcasting being a one way medium. This name is used to describe podcasts that provide teaching material as well as news and information.

3 Previous Evaluations of Podcasts in Higher Education

Podcasting in higher education has caught on but evaluation data is scarce and only a few universities have published their results—this section summarises their experiences. An online survey for the podcast pilot in 2005 at University of Washington reported by Lane (2006) found that 70% of students said that the LectureCasts supported their learning and were helpful when preparing for homework and exams. The response rate was low, 41 out of 148 enrolled students completed the voluntary survey, but this may indicate the perceived value. Interestingly, 81% of the students used a desktop computer rather than a portable player to listen to the podcasts. The University of Southern California had two spring courses in 2006 with their LectureCasts being evaluated with the outcome regarded as positive in both cases (Wolff, 2006). However, the reasons for their success differed. One course had a large number of students for whom English is their second language who listened to the whole lectures again. The participants in the second course valued having the recording to replay specific explanations to understand difficult material.

At the University of Canterbury an initial survey asked students to report their level of interest (5-point scale from 1 for not interested to 5 for very interested) for three types of material in the podcasts. The number of students showing an interest level of 4 or 5 (i.e. more than neutral) was 50% for the recordings of lectures, 72% for summaries and extra information, and 65% for related topical issues. Overall the students indicated a preference for the supplements, although the demand for LectureCasts is present (Bell et al., 2006). A deeper analysis of the collected surveys in this study revealed that students are very reluctant to respond to open ended questions. Likert scale or tick-box style questions were far more likely to be answered. This is important for future questionnaires as some respondents may have been ‘turned off’ by the large amount of writing required.

The results from the previous evaluations have lead us to believe there is a need for both LectureCasts as well as Sup!Casts. It appears that podcasted lectures are especially useful for students for whom their native language differs from that of the course. Also, the opportunity to be able to replay all or certain parts of a lecture is valuable when the material is complex, if the student lost focus or simply did not attend. It seems that LectureCasts are used in conjunction

with other study equipment, e.g. looking at/writing notes, reading textbooks and viewing websites for additional material. This reinforces our view that podcasting lectures does not take full advantage of the potential of the medium to facilitate mobile learning in the same way that Sup!Casts do.

4 Evaluation Methodology

In higher education it is quite common for practitioners themselves to carry out the evaluation of a project and critics have raised concern, hinting at bias and low priority in carrying them out. However, evaluation by the team involved also has advantages, such as timeliness, understanding of the innovation and access to the data (Oliver, 2000). To appease critics Oliver has produced a structured model of evaluation design that incorporates six stages, with steps one, two and six relating to context, and the remaining three focusing on the details of the study. In this section we describe these steps and how they will be followed in the evaluation of ProjectPodcast:

(1) Identification of Stakeholders: Stakeholders are all of the people that have some interest in the project or the evaluation of it. In the case of ProjectPodcast we have three groups of stakeholders: the administrators, the lecturers and the students. The administrators include the funding body and the staff involved in organising and promoting the project. The lecturers are those in various departments who have volunteered to be involved in the project and produce podcasts for their courses. Finally, we have the students who will be listening to the podcasts.

(2) Selection and Refinement of Evaluation Question(s), based on the Stakeholder Analysis: Before commencing the evaluations, the questionnaires and the core interview questions will be shown to members of the administration and teaching staff to ensure the evaluation will provide them with all of the feedback they require.

(3) Selection of Evaluation Methodology: In any evaluation there is the choice between qualitative and quantitative methods. The area of learning technology is inherently multidisciplinary and we believe it is better to choose the evaluation method best suited to the situation instead of sticking to one paradigm. In our case we aim to mix the two, triangulating in order to achieve valid results.

(4) Selection of Data Capture Techniques: For the students this will mainly be through questionnaires and technical data collection but also some semi-structured interviews will be conducted. The questionnaires must be presented to students in a fashion that will encourage the most participation. There are two possibilities for this: an electronic online version or a paper based version. Electronic questionnaires are preferred, as they have several data collection advantages. Firstly, they allow easy data collation when the survey is completed,

reducing the chance of answers being misread or incorrectly entered into a computer system. Secondly, online systems allow easier dissemination to a large group of users. The main disadvantage of electronic surveys is that the response rate is usually less than that of paper based ones, exasperating the problem of low feedback rates that podcasting already suffers. We will try to circumvent this by using a web-based questionnaire, with the possibility of including a reminder system for those who don't complete the survey in a timely fashion.

Past experience has shown that the student group will be less willing to provide feedback. Student questionnaires will be anonymous and completed online, however interested students will also be able to volunteer for focus group discussions via a tick-box. We will also use technical records available from the podcast servers to create statistics on the number of downloads per podcast and where the podcasts were requested from, be it from on campus, at home or whether there is interest from overseas. It should be noted however that this data will be the number of accesses and may not be related to the number of times the podcasts were actually listened to.

The evaluation of the lecturer's experience will be through questionnaires and semi-structured interviews. The teaching staff will be completing their questionnaires and interviews during and after this project under different prerequisites than the students. They will have actively chosen to be part of this project and hence are likely to be more willing to provide feedback and discuss their experience. In the first instance a questionnaire will be used to gather basic statistical data, thematically grouped on our assumptions. Following the questionnaires, the lecturers will be interviewed to allow us to gain a more in depth knowledge and understanding of their experience and issues they had. The lecturer will not be left to their own devices during the project—training and advice will be given and reports of the problems they encounter throughout their podcasting experience will be noted.

(5) Selection of Data Analysis Techniques: Analysis of tick-box style questions will be performed with standard statistical analysis tools. The written comments from the questionnaires and the recorded interviews/focus group discussions will be combined into a report. The results from the evaluations will firstly be disseminated to the stakeholders, and used to improve the podcasting project. They will also be published to the research community to allow others to learn and benefit from our experiences.

(6) Choice of Presentation Format: Both a formative and a summative report will be presented to the stakeholders of ProjectPodcast.

5 ProjectPodcast Preparatory Evaluation Plan

In this section we discuss our plan for conducting the evaluations of both the student and lecturer populations, including considerations for timing, survey form structure and limitations.

Timing: The time(s) at which the evaluation(s) are given during the course should be considered carefully. Our previous experiences have found that the last lectures of a course are often poorly attended and so this is not an ideal time to elicit feedback. Running a survey half-way through a course may offer more benefits, as the lecturers are able to respond to feedback and adjust their podcasts appropriately. The online questionnaires give us the flexibility to choose the best time for each course, however we intend to run them both half-way through, as well as at the completion of the course. Some students may also be interested in participating in focus group discussions regarding their podcasting experience. These students will be rewarded with small gifts (such as vouchers to be used at the local café) for giving up their time. ProjectPodcast will include continuous dialog with the lecturers involved, allowing us to tap into their experiences. We will also send out online questionnaires and conduct interviews/focus group discussions after the course has finished. This will allow them to give us feedback on their complete experience, including how lecturers adjusted their podcasts after the student surveys midway through the course.

Survey form: The questionnaires (see appendix 1 and 2) we have created contain questions regarding age, gender and language proficiency to allow us to determine whether the medium is better suited to certain demographic groups. The Likert style questions are used to estimate the level of satisfaction a person has concerning podcasting. The questions are separated into four categories based on our assumption of a practical thematic division: technical/environmental issues, podcast content, pedagogical issues and overall impressions. The semi-structured interviews/focus group discussions will be based on a core set of questions from each of the four categories, with free conversation and comments encouraged.

Limitations: Drawing solid conclusions from surveys that have a low response rate is risky. Our survey has been designed to allow it to be as easy as possible for students to complete and to encourage feedback from the greatest number of respondents. However, if the survey is not widely disseminated then drawing conclusions will still be risky. One will often find that it is the students at the extremes (either those who love the idea or those who hate it) that are the ones who will make themselves heard the loudest. The medium is likely to be better suited to particular learning styles or demographic groups (e.g. auditory learners or students for whom English is a second language) and this is expected to show through in the results.

Conclusion

The aim of this work was to generate a preparatory evaluation plan to enable us to effectively and efficiently assess ProjectPodcast. From our experiences and that of others we have found that students are reluctant to give feedback on podcasts. To circumvent this we will use closed questions, with tick boxes and conduct the questionnaires using a web based system. This data will be combined with that gathered in the semi-structured interviews and focus group discussions. The survey will include the lecturers, as they have been overlooked in the past. This will allow for more rounded conclusions on the perceived value of podcasts to be drawn, with perspectives from both the teaching staff and students involved. Finally, positive results will be used to encourage management and funding bodies to continue their support for technology based projects of this kind.

Appendix 1 Student Questionnaire

STUDENT QUESTIONNAIRE

Following are several questions about your perception of and experience with podcasting. Please tick the appropriate boxes.

Age group: <20 21-25 26-30 31-35 36-40 >40

Course: Computer Science Economics Japanese Music Education

Gender: Male Female

English language proficiency: Native Speaker Fluent Speaker Average skills Basic skills

LC: LectureCast

SC: Sup!Cast

Technical/Environmental Issues

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
Downloading the podcasts was easy	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I listened to the podcasts on a mobile device	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I found the podcasts were distracting when I was performing other activities	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I had to focus intensely to follow the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Podcast Content

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
The podcasts had substance and were interesting to me	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I listened to all of the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
The length of the podcasts was about right	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I only listened to sections of the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Pedagogical Issues

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
The podcasts supported my studying	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I found them beneficial for the course	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
The podcasts suited my learning style	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I listened to the podcasts with enthusiasm	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Overall Impression

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
The podcasts were a great addition to my study-kit	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
There was a need for podcasts in this course	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I would encourage the use of podcasts in more courses	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
It was worthwhile listening to the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

I would be interested in participating in an interview/group discussion on my perception and experience with podcasting

Thank you for your time! We would appreciate your comments on podcasting in this course.

.....

.....

.....

.....

Appendix 2 Lecturer Questionnaire

LECTURER QUESTIONNAIRE

Following are several questions about your perception of and experience with podcasting. Please tick the appropriate boxes.

- Age group: 21-25 26-30 31-35 36-40 40-45 46-50 >50
 Course: Computer Science Economics Japanese Music Education
 Gender: Male Female
 English language proficiency: Native speaker Second language

LC: LectureCast

SC: Sup!Cast

Technical/Environmental Issues

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
It was easy to produce podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
The support I got was adequate for my needs	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I got support when I wanted it	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
The recording equipment was simple to use	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Podcast Content

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
I made a script before recording the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
It was easy to get people to participate in the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I found it easy to come up with material for the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I enjoyed working through this medium	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Pedagogical Issues

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
It supported my teaching	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
This was a useful medium for me in this course	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I think the podcasts aided the students learning	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
Feedback was easily obtained about the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Overall Impressions

		<i>Strongly agree</i>	<i>Agree</i>	<i>Undecided</i>	<i>Disagree</i>	<i>Strongly disagree</i>
The students seemed to appreciate my efforts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I was enthusiastic about producing the podcasts	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I would encourage the use of podcasts in more courses	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				
I found it a valuable use of my time	LC	<input type="checkbox"/>				
	SC	<input type="checkbox"/>				

Thank you for your time! We would appreciate your comments on podcasting in this course.

.....

References

Bell, T., Cockburn, A., Wingkvist, A. and Green R. (2007). "Podcasts as a Supplement in Tertiary Education: an Experiment with Two Computer Science Courses", *Proceedings of MoLTA 2007*, p. 70–77.

Lane, C. (2006). "Podcasting at the UW: An Evaluation of Current Use", *The Office of Learning Technologies*, University of Washington.

Oliver, M. (2000). "An Introduction to the Evaluation of Learning technology", *Educational Technology & Society 3(4)*, ISSN: 1436-4522.

Wolff, T. (2006). "Podcasting made Simple", *SIGUCCS '06*, November 5–8, Edmonton, Alberta, Canada.

Multimedia instruction in a work-integrated e-learning environment

Findings from the early stages of a design research project

Christian Östlund
University West, Sweden
christian.ostlund@hv.se

Lars Svensson
University West, Sweden
lars.svensson@hv.se

Karlheinz Kautz
Copenhagen Business School, Denmark
karl.kautz@cbs.dk

Abstract. This paper reports from a design process within an e-learning project. An e-learning web lecture on how to search the World Wide Web was created based on narrated screen captures and power point slides. A framework grounded in situated learning was used to create the multimedia instruction for the web lecture. Flexibility vs. collaboration, multimedia instruction vs. multimedia interaction and situated content vs. situated use headlines the discussion on challenges where theory and practice deliver conflicting implications for system design.

Keywords. Design Theory, E-learning, Multimedia instruction.

Introduction

Internet based e-learning is offering independence from time and space. Together with web-based multimedia, i.e. combining elements of text, image, sound and/or animations in an integrated and dynamic online format (Mackey and Ho 2006), an increased interactivity can also be achieved. Multimedia learning can be argued to encompass a wide range of activities, and definitions of the concept are often wide and imprecise. Mayer (2001) for instance defines it as “learning from words and pictures”. Still, the term multimedia learning points to the possibilities for bringing media rich e-learning courses that the learner can attend in their own pace and at times that suits them. In order to bring about multimedia learning, multimedia instruction is needed, i.e. a presentation involving words and pictures that fosters learning (Mayer 2001).

A search on learning AND multimedia at Web of science (isiknowledge.com) shows that most of the studies on multimedia learning involves university, high or elementary school students that participate in an online course with multimedia elements that rely entirely on a distributed learning environment (e.g. Nick et al

2003, Taasobshirazi et al 2006) or using an online course as a complement to increase efficiency (e.g. Mackey and Ho 2006, Montazemi 2006) or to overcome the time and space issue (McMillan & LeGrand 2003; Latchman and Gillet 2000). Mosegaard & Bennedsens (2003) and Torgerson et. al. (2003) uses multimedia to bring the learning situation closer to the context. Rapid technological development has brought the possibilities of multimedia to the attentions of instructors but too often instructors' fails to ground the design in research and theory (Hirumi 2002) or existing practice (Svensson and Ostlund 2005).

A great number of articles when searching the Web of science for learning AND multimedia deals with the cognitive aspect of learning (e.g. Grunwald & Corsbie-Massay 2006, van Merrienboer 2005) and the collaborative aspect of learning (e.g. Bouras & Tsiatsos 2006). The studies on multimedia in a work-integrated learning setting (e.g. McDonald 2004) are underrepresented and more research is needed into the area of how multimedia instruction can be used to support work-integrated e-learning.

A design approach to create sound multimedia instruction can be achieved by using the framework of Markus et al (2002) and Walls et al (1992). They propose a model where a design framework is firmly rooted in a kernel theory from which requirements are derived and transformed into principles for design (see e.g. Herrington and Oliver 1995, Hung and Chen 2001). This paper describes the design of a system for work-integrated e-learning within a project called the Swedish academy of county administration. The multimedia instruction design is synthesised from a design framework in multimedia learning (Herrington and Oliver 1995) and the graphical user interface design is grounded in human computer interaction (HCI) theories (see figure 1).

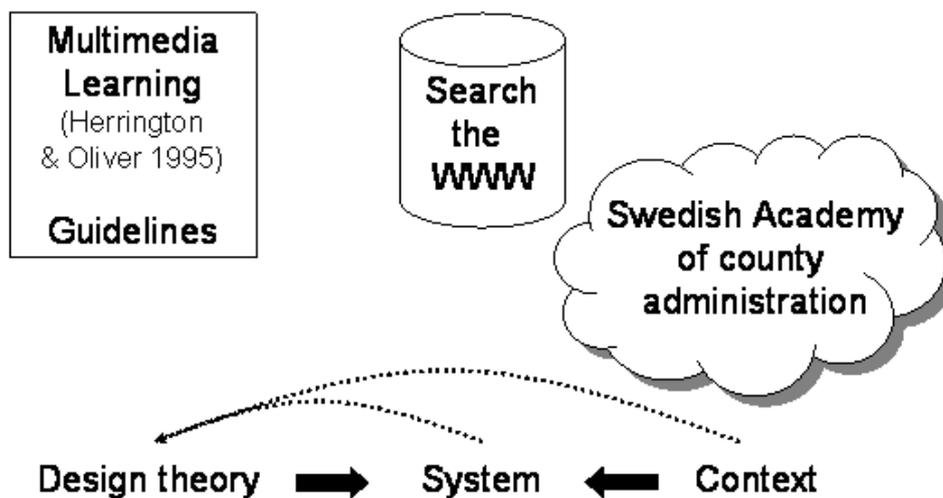


Figure 1. The design outline

The paper identifies and discusses challenges for multimedia design that surfaces through the interplay between design theory and the practice where the

system is intended to be used. Furthermore, the paper raises issues for further research that could evolve design theory on multimedia learning for work-integrated e-learning.

The research process

In their overview on design research in information systems Vaishnavi and Kuechler (2004) presents the general methodology of design research (figure 2) where the first step in the process is awareness of problem. The problem the authors of this paper are addressing is: *How can multimedia instruction support work integrated e-learning?* The next step is a suggestion for solution to the problem wherein:

“new functionality is envisioned based on a novel configuration of either existing or new and existing elements”.

In our case we try to adapt Herrington and Oliver’s (1995) framework for instructional design of multimedia in a work setting. Based on this and design guidelines derived from the HCI literature we developed a web lecture system.

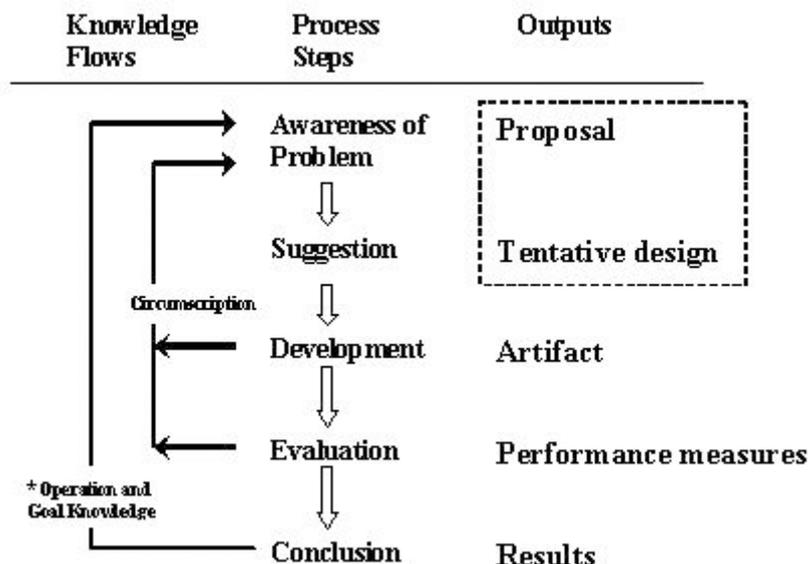


Figure 2. The general methodology of design research (Vaishnavi and Kuechler 2004)

The findings in this paper are from the three first process steps in Vaishnavi and Kuechlers’ (2004) model. The authors intend to evaluate the web lecture by doing a survey and interviews with the users of the web lecture and analyzing web logs to establish use patterns. We will then loop the process with a refinement of the web lecture and a new assessment.

In this next section the web lecture with its content will be described where after the design rationale will be described. The design rationale is described both

from a multimedia instruction point of view and a graphical user interface perspective. The experiences from this process are then discussed and some implications for further research conclude the paper.

The web lecture

The case setting is the County administration of Västra Götaland in Sweden within a project called the Swedish academy of county administration. The Swedish academy of county administration is a national e-learning initiative within the County administration. It aims at delivering web lecture and entire courses for all employees within a certain sector instead of e.g. 21 counties developing the same course in parallel, more or less without any co-ordination.

At first the web lecture was developed with a production tool provided by Microsoft and free of use for all owners of a PowerPoint licence called MS Producer. It was a very lean way of producing the web lecture, but the web lecture then only ran smoothly on Windows XP. Since some of the employees only had Windows NT, that posed a problem. The web lecture was then re-designed using basic XHTML-pages with frames, where the streamed video clips were imbedded in the XHTML-pages. This also gave more freedom for implementing a sound multimedia instruction and a user friendly graphical interface.

The web lecture will be part of a longer IT introduction all new employees at the County administration will need to take before getting access to the network, but can also be an alternative for employees who want to improve their ability to search the WWW. The web lecture consists of streamed video at 640 x 480 pixels imbedded in XHTML pages to the right with a navigation scheme for the streamed video clips to the left and the main navigation scheme at the top (see figure 3). The videos are either narrated slides or narrated screen captures of e.g. a search for Beatles homepage using the Google search engine.

Through the main navigation scheme you can also reach a discussion board, contact the teacher (in this case the same person who narrated the web lecture) and a link list with additional resources on how to search the WWW. They can also get back to the starting page (Home) of the web lecture where the overall aim of the web lecture and the main navigation scheme are explained.

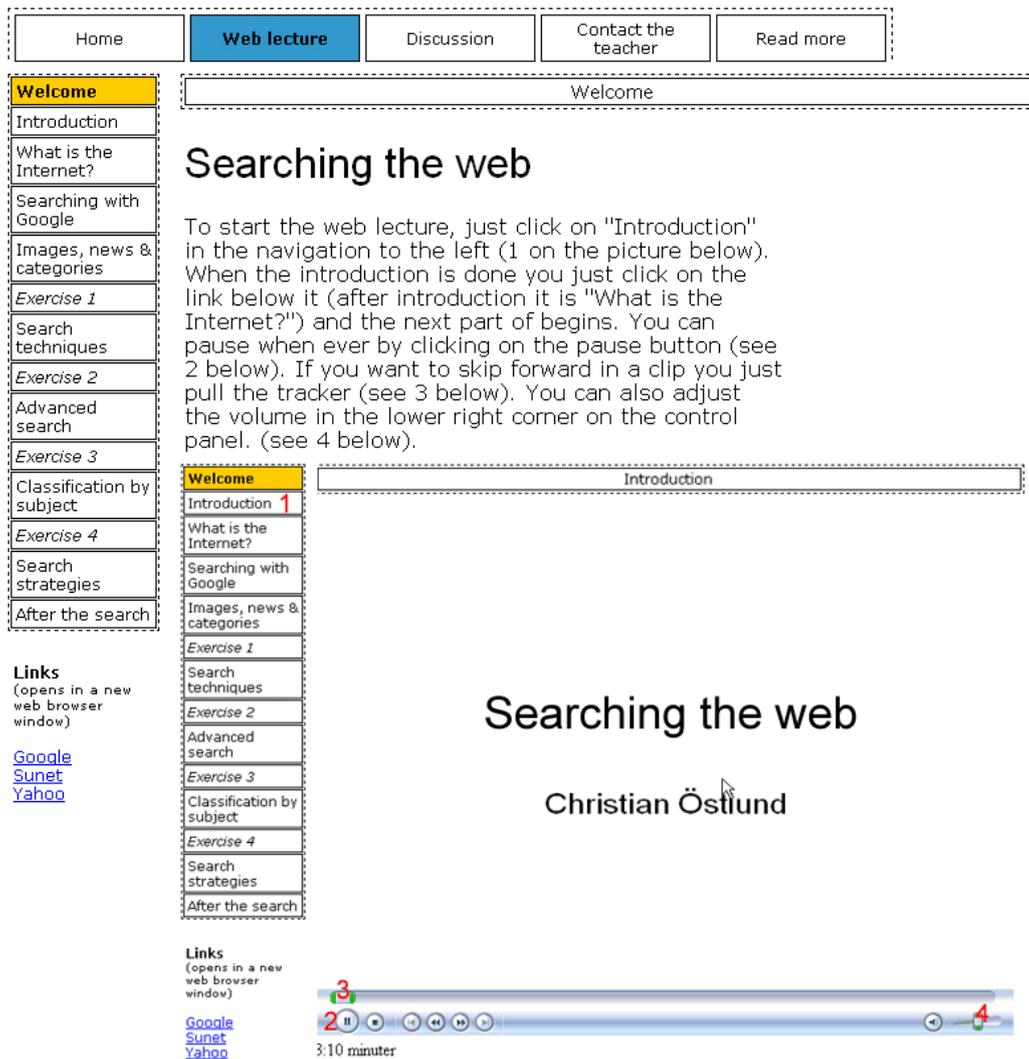


Figure 3. The welcome page for the video clips that make up the core of the web lecture.

The web lecture consists of an introduction, search techniques and search strategies with 4 assignments in between. In all there are nine modules ranging from 3 to 8 minutes each. The introduction gives a short history of the Internet, touches upon the WWW as an information resource, different ways of searching (free text searching vs classification systems) and problems of finding what you search for.

The module on search techniques uses Google as example but the techniques are applicable on most free text search engines. The different categories to search within: Web, Images, Groups and Category/Classification, are presented along with how to use the minus sign for excluding words and the quotation marks to search for phrases. Advanced searches, such as searches within a certain domain, from a certain date and so on are also elaborated upon.

The module on search strategies discusses alternative sources for information retrieval such as intranet and libraries and the importance of critical consideration of the sources to information found on the WWW. Different strategies on how to use the right set of key words are also discussed.

Design rationale for the multimedia instruction

There are several information system design theories (ISDT) for multimedia learning that are rooted in different kernel theories of learning. Samaras et. al. (2006) argues that behaviourism and cognitive science are the two most influential learning theories for instructional design whereas Mackey and Ho (2006) also mention constructivism. However, with respect to the specific nature of work-integrated e-learning we argue that socio cultural theories of learning are highly interesting since this tradition highlights the situated nature of learning and the close interrelation between learning and practice (Wenger 1998, Lave and Wenger 1991). There are several recent contributors to ISDTs rooted in social theories (see e.g. Herrington and Oliver 1995, Hung and Chen 2001, Hardless 2005). For the purpose of this paper we structure the design rationale presented in this section using the Herrington and Oliver (1995) framework. This framework highlights the central dimensions of socio cultural views on learning in a structured way.

Herrington and Oliver's (1995) framework is influenced by the work of Lave and Wenger (1991) that takes a point of departure in the individual when approaching situated learning. Using their framework for the instructional design of interactive multimedia, Herrington and Oliver (1995) ends up with three mutually constitutive elements of the learning process with sub categories that sums up the critical characteristics of situated learning for instructional design. (see figure 4).

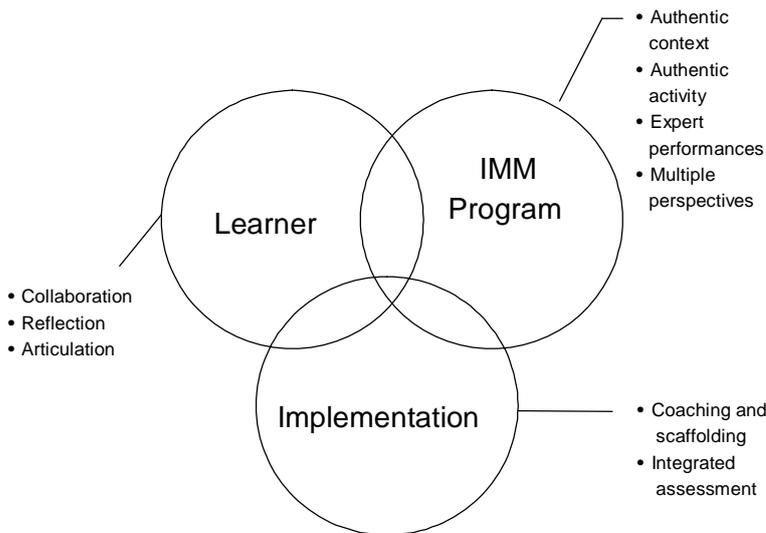


Figure 4: Constitutive elements of situated learning in interactive multimedia (Herrington and Oliver 1995)

We have used the sub categories of these three elements to structure the presentation of the instructional multimedia design of the web lecture.

Authentic context

A situated learning environment should provide an authentic context that reflects the way the knowledge will be used in reality (Herrington and Oliver 1995). In a similar way Hung and Chen (2001) promote that e-learning environments should create a situation where there is continual interest and interaction embedded in the environment. The web lecture uses the Google search engine when exemplifying the different search techniques. The Google search engine is the most commonly used within the organisation as well as world wide, and even if the learners in the future should choose to use an alternative search engine the search techniques does not differ radically when it comes to the essential ways of searching. Most probably, they will use Google in the same way as in the web lecture and at the same computer.

Authentic activities

A situated learning environment should also provide an ill-defined authentic activity that encourages the students to find and solve problems (Herrington and Oliver 1995). The examples used when exemplifying the different search techniques are not from their everyday work practice and they are encouraged to use examples from their work practice in the different assignments. Manipulating with the material also enhances learning rather than just passively observe others manipulate the material (Moreno 2006) which is why there are four assignments

where they use the different search techniques on their own. This is also stressed by (Hung & Chen 2001) when they state that e-learning environments should facilitate the activities and processes in which the learners are engaged.

Expert performance

Situated learning environments provide access to expert performances by letting the student observe the task before they try themselves (Herrington and Oliver 1995). In the web lecture a university teacher demonstrates the different search techniques to the students by recording actual searches with screen captures that are shown to the students. As mentioned above the students then attempt to use these techniques on their own.

Multiple perspectives

A situated learning environment provides the learner with the opportunity to investigate multiple roles and perspectives (Herrington and Oliver 1995). In the web lecture different ways of searching, e.g. free text searching vs classification systems and searching the WWW vs going to the library are discussed. Furthermore the students are provided with on-line resources where they can go into depth and read about the subject from other perspectives.

Collaboration

A situated learning environment supports the collaborative construction of knowledge (Herrington and Oliver 1995). The flexible character of the web lecture makes it difficult to support and promote real time collaborative learning since it is very uncertain how many students will take the web lecture simultaneously. Collaborative learning could to some extent be supported and promoted via a threaded debate board where students could be asked to post difficult “searches” of interest for their work and how they solved the problem. Then others could be invited to comment or even help if the problem is not fully solved.

Reflection

Students learn better when they are given the opportunity to reflect during the meaning-making process (Moreno 2006), hence a situated learning environment promotes reflection to enable abstractions to be formed (Herrington and Oliver 1995). By using examples that are not from their daily practice, in our case a search for the Beatles on the WWW (see figure 5), and then encouraging the students in the following assignment to use the techniques with search words that mirrors their own work practice we help them reflect on what they have learned

and how it can be used in their daily practice. In this way the e-learning environments focus on real tasks and enables learning through doing and reflection-in-action (Hung & Chen 2001).

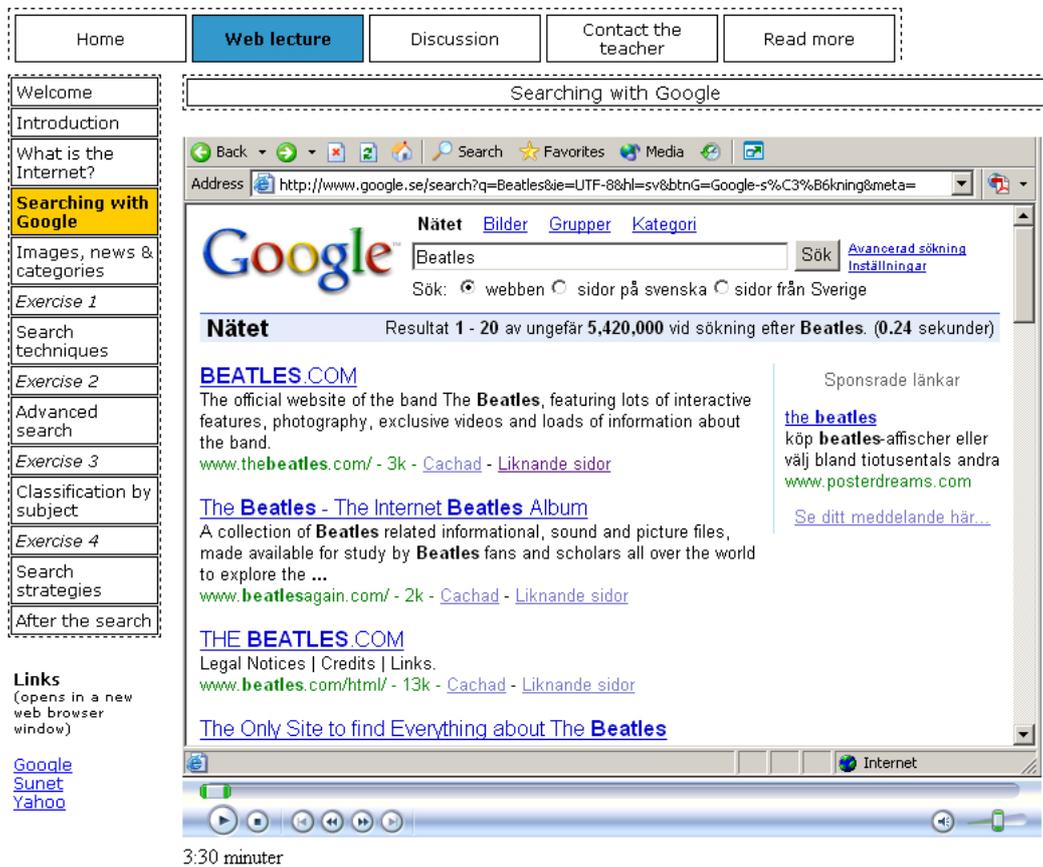


Figure 5. A narrated screen capture exemplifying a search in Google

Articulation

A situated learning environment promotes articulation to enable tacit knowledge to be made explicit (Herrington and Oliver 1995). In e-learning environments this is often supported by debate boards where students groups are to reflect on a subject and give substantial comments on other students' comments as a part of the examination (e.g. Trevitt 2002). Again the flexible nature makes it hard to create working groups for the students but a debate board where the students can evaluate and self assess what they have learned during the web lecture could be a possibility.

Coaching and scaffolding

A situated learning environment provides for scaffolding of support and coaching at critical times (Herrington and Oliver 1995). The students will during the web lecture be able to e-mail the teacher if there is something that is unclear or if they have questions in general. During the period of time when the web lecture is being tested the students will receive feedback within 24 hours and often sooner. Hung and Chen (2001) argue that e-learning environments should have scaffolding structures that utilises the genres and common expressions used by the community. In our case the teacher is not from the County administration, so that could pose a potential problem. Being aware of this problem the teacher will check any uncertain questions with the case representative at Swedish academy of county administration.

Integrated assessment

A situated learning environment should provide for integrated assessment of learning within the tasks (Herrington and Oliver 1995). All the participants in the web lecture will receive a survey where they will, among other things, be asked to self assess what they have learned during the web lecture and in what way they have used their new knowledge. This will be used to re-design the web lecture if necessary. For the purpose of our case interviews with some of the participants will also be made.

Design rationale for the graphical user interface

Web usability is the ease with which users are able to use a web site (Nielsen 1998). It is important that web based e-learning is user friendly so frustrations with a badly designed graphical user interface does not interfere with the learning that is meant to take place since web usability factors can have a positive effect on students perceived learning (Mackey and Ho 2006). Furthermore it is important that all the parts of a system are visible and that it is clear where in the system the users are (Norman 1988). The main sections of the web lecture are available at the top of the screen and what section you are in and where in that section is made clear by colours and followed links change colour to the standardised purple colour. This also answers the three fundamental questions of navigation; where the users are, where they have been and where they can go (Nielsen 1998).

The user should always get full and continuous feedback on all the choices they make. It should be easy to determine the outcome of actions on beforehand (Norman 1988). When a user clicks on one of the videos that make up the web lecture they see under the area where the video is shown how long that video is

and if it does not start immediately they see the windows player and that it is buffering. The users are informed on beforehand if the links they click on are opened in another window or not. Since the users all are from Sweden the different ways of perceive colour is not an issue. The different links are either traditional blue underlined links the users will recognise or they are made to look like a button so it will be natural to click on them.

If the users have any previous experience it is important to take advantage of them. Achieving similar tasks should have similar operations and use similar elements throughout the system (Norman 1988). The buttons that are used to manipulate the video streams (e.g. play, pause) are the default ones from MS Windows Media Player and resembles the buttons users are familiar with from e.g. DVD and CD players. Most of the larger web sites on the internet have the navigation at the top or to the left. The web lecture have a main navigation at the top and in those cases where a complementary navigation is needed it is placed to the left, below the main navigation at the top. The navigation takes up less than 20% of the screen which leaves more then 80% for the information which is preferable (Nielsen 1998). In order to enhance readability the text is black sans serif against white background. The sentences are not longer than 60 positions so the user do not lose track of what the next sentence are (Nielsen 1998). The system is adapted to a resolution of 800x600 which all the employees who will participate in the web lecture have. Although Nielsen (1998) recommend that screens should be adapted for 640x480, the intended users of in our case judged by the authors to have at least the resolution of 800x600.

Mayer and Chandler (2001) argue that simple user interaction, i.e. user control over the words and pictures in the multimedia presentation, reduces the learner's cognitive load on the memory and thereby enables the learner to progressively build a coherent mental model. In our web lecture the multimedia parts are stopped after each clip giving the users time to reflect or immediately move on. The users can also pause a clip or watch it several times, right away or later.

Discussion

Existing design theories for multimedia instruction is to a large extent based on the conditions of full-time studies in educational institutions. Under those conditions it is easier to achieve a positive collaborative effect with multimedia elements (Cadiz 2000) in the instructional design than when employees' are learning alone in front of the computer and at time intervals that sometimes are out of their own control. A central challenge to explore is how ISDT will be affected when learners do their studies integrated with full time employment.

The previous section describes several aspects within the design space where guidelines from design theory agrees well with implications for work-integrated e-learning derived from practice.

Examples of such areas are:

- Video-clips and teacher-learner interaction allows for rich demonstrations of *expert performance* and *coaching*.
- Assignments that draws on personal experiences call for *reflections*, and supports *articulation* of work-related problems.
- Heterogeneity of participants has the potential of demonstrating a wide variety of *perspectives* that can provide *authenticity* of contexts and activities.

The examples above can all be argued to support the authors' claim that socio-cultural views on learning are well suited for capturing the specific conditions that are connected to work-integrated e-learning. However, the previous section also reveals a series of challenges where theory and practice deliver conflicting implications for system design, and even though design practice inherently involves resolving conflicts between contradicting guidelines from theory in wicked and ill-defined problem areas we still believe that the following three challenges need further attention in order to develop ISDTs for work-integrated multimedia learning.

Flexibility vs. collaboration

The importance of collaboration and collective processes of sense making and negotiation of meaning is a central aspect in the socio-cultural views of learning (e.g. Wenger, 1998). Hung and Chen (2001) stress the social and collaborative side of learning by stating:

“E-learning environments should capitalize the social communicative and collaborative dimensions allowing mediated discourse.” However, an important argument in favour of multimedia e-learning as an approach to work-integrated learning is the flexibility it potentially affords with respect to time and space, and collaborative activities inherently come with coordination costs and interdependencies between participants that constrain flexibility for the individual learner.

Multimedia instruction vs. multimedia interaction

Using multimedia technologies in work-integrated e-learning has great potential when it comes to mediating rich and authentic information from instructor to learners, but the design framework does not give equal attention to the need for learners to present and share the situated nature of their respective work practice with other learners and with the instructor(s). Hence, mediation of learners' contexts is often restricted to text-based communication. To stress the need for multimedia communication is not only a question of allowing for the learner to share their work context with others, it is also an important aspect in order to

mediate other collective processes such as shared negotiation of meaning and sense-making (Wenger, 1998)

Situated content vs. situated use

Finally, in light of the experiences from the design project described in this paper it is evident that ISDT for e-learning in general, and the Herrington & Oliver (1995) framework in particular adopt a somewhat one-dimensional view on the meaning of the situated nature of learning that is stressed in socio cultural learning theories (see for example Lave and Wenger, 1991). The design guidelines focuses primarily on the need for instructional content to be authentic and aligned with the learners' situation and objectives, and thereby missing out on the design implications that comes from the context in which the learner has to conduct her studying. Learning at work means that learners are forced to plan and perform their studying activities in competition and integration with other work tasks that need to be done. This also points to the need for instructional design that allows for studying that to some extent can be modularised and interwoven with everyday practice.

Conclusions and further research

Experiences from applying design theory to a concrete case of work-integrated e-learning reveal three central challenges and dilemmas that call for further research in the areas of net-based collaborative and work-integrated learning and how multimedia instruction should be used in such contexts. By approaching these challenges in further research we hope to develop IS design theories for work-integrated e-learning and subsequently address the following questions.

-How could instructional design be made to reflect the fact that it is learning "in work" rather than learning "for work"?

-How could multimedia instructional design reflect the need for coping with restrictions on flexibility that come from work activities that competes with students' attention on learning?

-How could multimedia instructional design theories reflect the need for individual learning, even though they are rooted in social theories of learning?

References

- Bouras, C. and T. Tsiatsos (2006). "Educational virtual environments: design rationale and architecture." *Multimedia Tools and Applications* 29(2): 153-173.
- Cadiz, J. J., Balachandran, A., Sanocki, E., Gupta, A., Grudin, J., and Jancke, G. (2000). "Distance learning through distributed collaborative video viewing". In *Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work (Philadelphia, Pennsylvania, United States)*. CSCW '00. ACM Press, New York, NY, 135-144.
- Grunwald, T. and C. Corsbie-Massay (2006). "Guidelines for cognitively efficient multimedia learning tools: Educational strategies, cognitive load, and interface design." *Academic Medicine* 81(3): 213-223.
- Hardless, C., (2005) "Designing Competence Development Systems", Doctorial dissertation, Department of Informatics, Gothenburg University, Sweden. 2005
- Hirumi, A. (2002). "The Design and Sequencing of eLearning Interactions:A Grounded Approach". *International Journal on E-Learning*. 1 (1), pp. 19-27. Norfolk, VA: AACE.
- Herrington, J., & Oliver, R. (1995). "Critical characteristics of situated learning: Implications for the instructional design of multimedia." In J. Pearce & A. Ellis (Eds.), *Learning with technology* (pp. 235-262). Parkville, Vic: University of Melbourne.
- Hung, D. and Chen, D., (2001) "Situated Cognition, Vygotskian Thought and Learning from the Communities of Practice Perspective: Implications for the Design of Web-Based E-Learning". *Education Media International*, 38(1): 2001 pp 3-12.
- Latchman, H., A. & Gillet, D., (2000) "A New Approach in the Use of Multimedia for Technology Enhanced Learning", in *proceedings of the American Control Conference, Chicago, USA*
- Lave, J. & Wenger, E. (1991) "Situated learning: Legitimate peripheral participation." Cambridge: Cambridge University Press.
- Mackey, T. P., & Ho, J., (2006) "Exploring the relationships between Web usability and students" ..., *Computers & Education* (2006), doi:10.1016/j.compedu.2006.08.006 (In press)
- Merrienboer, J. J. G. van and J. Sweller (2005). "Cognitive load theory and complex learning: Recent developments and future directions." *Educational Psychology Review* 17(2): 147-177.
- Markus, M. L., Majchrzak, A., and Gasser, L. (2002) "A Design Theory for Systems that Support Emergent Knowledge Processes". *Management Information Systems Quarterly*, 26(3): 2002 pp179-212.

- Mayer, R. E. (2001). *Multimedia learning*. Santa Barbara: Cambridge University Press.
- Mayer, R.E. and P. Chandler, (2001) "When Learning Is Just a Click Away: Does Simple User Interaction Foster Deeper Understanding of Multimedia Messages?" *Journal of Educational Psychology*, 2001. v93 n2 p390-97 Jun 2001.
- McDonald, D. S. (2004). "The influence of multimedia training on users' attitudes: lessons learned." *Computers & Education* 42(2): 195-214.
- McMillan, T. & LeGrand, D., (2003) "Using Video Lectures and Course Management Software to Supplement a Traditional Classroom-based Course", *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Vol. 2003, Issue. 1, pp. 396-397
- Montazemi, A. R. (2006). "The effect of video presentation in a CBT environment." *Educational Technology & Society* 9(4): 123-138.
- Moreno, R., (2006) "Learning in High-Tech and Multimedia Environments" *Current Directions in Psychological Science* 15 (2), 63–67.
- Mosegaard, J. & Bennedsen, J. (2003) "A Framework for Narration and Learning in Educational Multimedia", *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Vol. 2003, Issue. 1, 2003, pp. 99-106
- Nick, S., Andresen, J., Lübker, B. and Thumm L., (2003) "CHEMnet—Structure, Design, and Evaluation of an Online Chemistry Course", *Journal of Science Education and Technology*, Volume 12, Number 3 / September, 2003
- Nielsen, J., (1998) "Designing Web Usability: The Practice of Simplicity", New Riders Publishing, United States of America
- Norman, D., (1988) "The Design of Everyday things" MIT Press, United States of America
- Samaras, H., Giouvanakis, T., Bousiou, D. & Tarabanis, K. (2006). "Towards a New Generation of Multimedia Learning Research". *AACE Journal*. 14 (1), pp. 3-30. Chesapeake, VA: AACE
- Svensson, L. and Ostlund, C., (2005) "Emergent Design Concepts - An inductive approach to bridging design theory and educational practice" *WSEAS Transactions on Advances In Engineering Education*, Issue 3, Volume 2, July 2005 with the title (ISSN 1790-1979).
- Taasobshirazi, G, Zuiker, S., Anderson, T. and Hickey, D., (2006) "Enhancing Inquiry, Understanding, and Achievement in an Astronomy Multimedia Learning Environment" *Journal of Science Education and Technology*, Vol. 15, No. 5, December 2006

- Trevitt, C. (2002). "Coaching the transition to e-learning: re-thinking instructional design". World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2002, Montreal, Canada, AACE.
- Torgerson, C., Blasko, D., Kazmerski, V. & Cornwell, J., (2003) "Using Interactive Multimedia to Learn and Apply Observational Research Methods" World Conference on Educational Multimedia, Hypermedia and Telecommunications, Vol. 2003, Issue. 1, 2003, pp. 928-931
- Vaishnavi V. and W. Kuechler (2004). "Design Research in Information Systems" July 27, 2004. URL: <http://www.isworld.org/Researchdesign/drisISworld.htm>
- Walls, J. G., Widmeyer, G. R., and El Sawy, O. A. (1992) "Building an Information System Design Theory for Vigilant EIS", Information Systems Research (3:1), 1992, pp. 36-59
- Wenger, E. (1998). "Communities of Practice: Learning, Meaning and Identity". Cambridge U P, New York, USA

One for all, and all for one? Identifying clusters of user behaviour in intranet search engine log files

Dick Stenmark and Henrik Strindberg
Viktoria Institute, Sweden | Findwise AB, Sweden
dist@ituniv.se | henrik.strindberg@findwise.se

Abstract. In recent years a substantial amount of research has been focusing on how ordinary web users interact with search engines. However, these users are tacitly assumed to be a homogeneous group by researcher and vendor alike. We argue that search engine users should not be treated collectively and by applying automatic clustering technique based on self-organising maps to search engine log files from a corporate intranet, we show that users can be separated into distinguishable segments based on their search behaviour. Analysis of these segments teaches us more about (intranet) searching and when designing and implementing future tools for information seeking and retrieval, these tools can be targeted to specific segments rather than to the population as a whole. We found that a large group of users appear to be casual “fact seekers” who would benefit from higher precision, a smaller group of users were more holistically oriented and would likely benefit from higher recall, whereas a third clique of users seemed to constitute the information-seeking savvy employees. All these three groups may raise different design implications for search tool developers.

Keywords. Search engine, Search behaviour, Intranet, Self-Organising Maps, Cluster.

Introduction

If you were a King’s Musketeer in the 17th century France, as in Dumais’ novel *The Three Musketeers*, a slogans such as *One for all, and all for one* may have been plausible. In today’s society, however, life appears to have become more complex and possibly more individualistic and one size no longer fits all. Yet,

groups and group affiliations continue to have an impact on our social lives and some would argue that group identification is an inevitable – and a desired – aspect of modern life (*cf.* Young, 1990). In this argumentative paper, we discuss whether users of an information seeking tool should be understood and analysed as individuals with unique requirements and preferences or seen as contributors to a collective behaviour that may be described using mean values and averages. We argue, although both extremes have their merits, that too often has the user been bundled with thousands of others at the expense of finer details and deeper understanding. At the same time, the analysis of thousands of individuals would be extreme resource consuming whilst results based on the examination of a handful could easily be biased. We therefore suggest a middle way, where search engine users are grouped and analysed based on similarities in seeking behaviour.

A decent amount of research on how ordinary web users interact with public search engines such as AltaVista (Silverstein et al., 1998), EXCITE (Jansen et al., 1998) or Alltheweb (Jansen & Spink, 2003), has been carried out over the last decade. Automatically generated log files from these systems have been studied and have generated useful statistics on the amount of time typically spent with the search tools, the average query length, the mean number of result pages examined, the use of advanced features and Boolean operators (or the lack thereof), and these studies have allowed us to notice emerging trends in user behaviour. We hence begin to know a few things about the average search engine user. However, as Cooper (1999) argued, *there is no such thing as a typical user*. It must be assumed that people who search for information have different levels of experience and education, diversified and personalised information needs and thus behave very differently. To only look at some average numbers cannot provide the full picture, we argue. Other methods should be applied to broaden our vision, and we suggest automatic clustering as a promising approach.

Web usage mining is the activity of (automatically) discover and thereafter analyse patterns of behaviour from interacting with Web servers (Cooley et al., 1997). Automatic clustering of resources in general is an area that has received much attention from (primarily) computer science researchers (Mekhaldi et al., 2004). Maarek and Ben-Shaul (1996) note that although there is no strict definition of cluster, there is a general agreement that a cluster is a group of objects whose members are more similar to each other than to the members of any other group. In line with this comment, we understand clustering as the process of organising object into groups based on some sort of similarity between the objects so that that intra-cluster similarity is high and inter-cluster similarity is low(er) (*cf.* Maarek & Ben-Shaul, 1996).

Our aim is not to invent new algorithms. Instead, we contribute to the understanding of search engine usage by showing that clustering of users based on behaviour is both feasible and informative. Instead of investigating common variables such as number of query terms or search session duration *one by one*,

this study draws on market analysis (Kotler et al., 1996) and examines a large number of commonly studied search variables simultaneously. These variables are used to form an 11-dimensional vector for each user and Self-Organising Map (SOM) technique is used to reduce the data and project it onto a two-dimensional grid, which makes it possible to visualise the result. We thereafter cluster the data to identify segments of similar usage and qualitatively analyse the characteristics of these clusters. By identifying similarities within and differences between clusters of intranet users, we provide valuable knowledge for design of future search tools which can result in improved system performance and enhanced search quality.

Previous work on user clustering

Much of the work on clustering has focused on developing new algorithms or methods for clustering (cf. Li & Chung, 2005; Li et al., 2005; Wang and Kitsuregawa, 2003). This is understandable since this technical aspect certainly is important, but an information system is only useful if it fits the needs of its users. Only if we know how users behave when interacting with search engines can we design tools to better support the search process (Baeza-Yates et al., 2005).

Marketing people have since long recognised the fact that not all customers behave the same. To address the problem of identifying potential customers within a heterogeneous market, one approach has been to divided customers into homogeneous segments of buyers, thereby making it possible to diversify product design, marketing strategies and other efforts to best suit each segment for maximising the sale of a product or a service (Kotler et al., 1996). A common way of segmenting customers is to use various statistical and data mining methods. One of the most widely applied techniques in this regard is the basket analysis, which is often used in reselling and banking and can be described as to determine correlations between different products placed in the same shopping basket (Berry & Linoff, 1997).

By combining this correlation among products with demographic data for specific customers, e-commerce vendors are trying to predict buying patterns amongst site visitors. In their study of recommender systems in the apparel domain, Ghani and Fano (2002) argue that this approach is relevant not only to their context but to a wider class of products and that abstracting from the product layer to attributes such as personal tastes can add a potentially valuable dimension to such systems. With the same reasoning we suggest a similar approach to segmenting intranet search engine users by looking at characteristics of their information seeking behaviour.

There are a number of studies where the users' behaviours have been captured in order to enhance their search experience. For instance, Liu et al. (2002) leveraged users' search history to construct automatically individual profiles to

disambiguate the words in the users' query. They let the server track the users' search patterns and learn the users' long-term interests in an unobtrusive way but their aim was to provide personalised search result to each user and not to identify clusters of user behaviour. Xue et al. (2004) also took advantage of accumulated search engine log files to improve searching by exploiting click-through data. Through their new algorithm they were able to add more accurate metadata to web pages, and thereby improve relevance. They did not, however, try to learn anything about the users' behaviour in general. Also Baeza-Yates et al. (2005) set out to model users' search behaviour by analysing search engine log files. Baeza-Yates and colleagues consider several parameters in a non aggregated way to suggest three different models of search engine interactions. However, their models describe general user behaviour and do not attempt to distinguish between different segments of behaviour.

Our work differs from the above in several important ways; we examine the behaviour of *intranet* users – a group thus far often neglected; we use *11 different parameters* to describe and characterise behaviour – a much broader approach than in most previous studies; and we identify *naturally appearing groups* of users and user behaviour and discuss the implications the existence of these groups may have on search tool design.

Research context and method

In the following section, we account for the search engine and the context in which it operates, and for the research approach used for this work.

The TransMech intranet

This study is based on real data from real users with real information needs. The log file was obtained from the TransMech intranet in 2004. TransMech is a European hardware manufacturer with offices and factories in many countries around the world. In 2004 there were approximately 70,000 employees in the company group, which consisted of nearly a dozen individual companies. The TransMech intranet was started in 1995 and did in 2002 consist of more than 1,500 web servers. The exact amount of documents (or web pages) available on the intranet was impossible to determine, but corporate officials estimated it to be in the region of 8-900,000 documents. Content was typically work-related and provided by a relatively small group of informants in a top-down fashion.

Since 1998 TransMech uses Ultraseek as their intranet search engine. Ultraseek is a commercially available keyword-based search engine that allows the use of + (plus) and – (minus) to indicate that a term **MUST** or **MUST NOT** appear in the document (instead of Boolean operators such as **AND** or **NOT**). Quotation marks are used to indicate a string search and all these features may be

combined. For example, the query apple –mac “fruit salad” would mean a search for documents containing the word apple, but not the word mac and the phrase “fruit salad”. Results are returned in chunks of 10 where the user may access the next chunk by clicking the “next” button.

Research method

The raw data was collected between October 14th and October 21st 2004 from TransMech’s search engine as a transaction log in the combined log format. The log details include information such as IP-address, time stamp of access, and what kind of request that was made. The request part of the log entry consists of a different number of Ultraseek parameters most of which are neglected in this analysis.

The log file contained 61,679 entries. We sorted the log file on IP-address and datetime, and the number of activities from each unique IP-address was counted. The most active addresses were examined manually to identify and remove obvious proxies (i.e., servers relaying queries from multiple users). After this modification, which removed a total of 109 IP-addresses, the cleaned set contained 7,902 IP-addresses, which now were considered to represent individual users.

Even though transaction log analysis (TLA) is a well-established method (see Jansen, 2006), it must be acknowledged that no standardised metrics have been agreed upon and interpretations and definitions differ between studies (Li et al., 2005). To construct our vectors, we have collected the parameters most frequently used in TLA-based studies conducted on both the Internet and on intranets. In table 1 below we offer our interpretation of them.

Table 1. Information seeking variables used in this study

1. Query length (“mean no. of terms of per query”)

A term is defined by Jansen et al. as: “...any unbroken string of characters (i.e. a series of characters with no space between any of the characters” (Jansen et al., 1998, p. 211). Terms thus included words, acronyms, numbers, symbols, URLs, or any combination thereof. We have followed this definition. However, we choose not to include zero length queries.

2. Number of find similar (“mean no. of clicks per session”)

This is an Ultraseek feature similar to Google’s Similar pages. For each document link on the result page the user can click the Find similar link to retrieve more pages similar to the particular result document. This parameter holds the number of such requests made by the user.

3. Time examining documents (“average time in seconds”)

In Jansen and Spink’s (2003) study they calculated the time each user spent reading a retrieved document as the time from clicking on the link until returning to the search engine. We copy that definition.

4. Time examining result pages (“average time in seconds”)

When the user is presented the result page there are typically five actions to choose amongst. The user can identify a promising link and click on it, which would take the user away from the search engine and display the actual document. Alternatively, the user may move to the next bunch of (ten) result links by clicking on a next button. A third option would be to revise the query and resubmit. The fourth action would be to click on the Find similar link (see 10). A fifth option would be to give up and leave the search engine. Unlike the first four, the last action does not generate a log entry. For this parameter we calculated the time from the result page was displayed to any of the first four actions was carried out.

5. Session duration (“average time in seconds”)

There are several ways to define session duration. The simplest one is to define the session duration as “measured from the time the user submits the first query until the user departs the search engine for the last time (i.e., does not return)” (Spink & Jansen, 2004, p. 44). This approach has been criticised as being too naïve, especially when the log file covers different days (He & Göker, 2000). A commonly used alternative is to look at the idle interval between two consecutive activities from the same user and if this interval is “long enough” considered it a session break. In our study we have used this latter approach, often referred to as the “timeout” method (Huang et al., 2004). To determine what is long enough, we have used the approach described in Stenmark (2005) and set the idle threshold to 13 minutes.

6. Number of queries (“mean no. of queries per session”)

A query is the search string entered by the user and defined by Jansen et al. (1998) as “one or more search terms, and possible includes logical operators and modifiers...” (p. 211). We have used the same definition and counted the number of queries submitted during a session.

7. Number of viewed hits (“mean no. of viewed documents per session”)

If a user clicks on any of the links on a result page, they have viewed a document. In Jansen and Spink’s (2003) study, they counted these activities and in this paper we copy this approach.

8. Viewed result pages (“mean no. of result pages viewed per session”)

When a user submits a query to the search engine, it typically returns a result page containing links to the (ten) best matching documents. This means that every user gets to view at least one result page. In this study, we do not count this first result page view (as it is trivial), but only explicit requests for result pages.

9. Number of activities (“mean no. of activities per session”)

The number of activities is the sum of all the interactions a user can have with the search engine, plus the inclusion of the user’s first view of the interface, prior to submitting the first query.

10. Number of sessions (“mean no. of sessions per active day”)

This parameter holds the mean number of sessions that the user engages in during an active day, i.e. a day when the search engine is used. Previous studies have not used the timeout method and thus only reported one session per day.

11. Number of active days (“no. of days”)

This parameter simply shows how many days the users visited the search engine during the measured seven days. It can thus range from 1 to 7.

As the number of products (or features or, as our case, variables) grows, the size of the distance matrix (i.e. product \times product) can become very large (Desmet, 2001). This means that manual processing becomes very difficult and here is where automatic clustering comes in handy. Desmet suggests and demonstrates the usefulness of Self-Organising Maps (SOM) to cluster and visualise the data through automatic processing. A SOM is thus particularly useful when data is numerous and when the distribution of the variables is unknown, and since this is exactly the case for search engine log file data, we apply the same method in this paper.

Using the above variables as input, we formed an 11-dimensional vector for each of the 7,902 logged users. Following previous approaches (e.g. Desmet, 2001; Vesanto et al., 1999), we thereafter fed these vectors into the MatLab software package. MatLab can be described as a numerical computing environment with its own programming language. The software provides easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages. To do the actual processing and to visualise the results, we used the SOM Toolbox¹.

¹ See Laboratory of Computer and Information Science (CIS), Department of Computer Science and Engineering at the Helsinki University of Technology. <http://www.cis.hut.fi/projects/somtoolbox/>

Before the vector values could be compared and visualised their values had to be normalised. The SOM toolbox uses Euclidian metric to measure distance between vectors and without normalisation, variables with higher absolute values would have greater impact on the distances measured than would variables with lower values (Vesanto et al., 1999). The technique used here is the default setting of the SOM toolbox, simply scaling all vectors elements to have the variance equal to one. After normalisation, the data structure was ready to be clustered. Since this is a non-trivial activity we describe this in more detail in the next section.

Self-organising maps

The concept of Self-organising maps (SOMs) can be described as a set of neurons organised as a fixed net of predetermined size. Each neuron is a d -dimensional weight vector where d is the dimension of the input vectors. On the output layer, the neurons are connected to their neighbours so that similar neurons will be closer together than more dissimilar neurons (Desmet, 2001; Vesanto et al., 1999). Similarity is based on the Euclidean distance as described by Vesanto et al. (1999). Many different forms of output can be generated, e.g., sheet, torus or cylinder, but typically a low-dimensional grid is chosen. For easy visualisation, we have chosen a 10×5 neuron sheet.

The approach used in this work is to cluster SOM rather than cluster the raw data itself, as suggested by Vesanto and Alhoniemi (2000). The primary benefits with this approach are that it significantly reduces the computational load and is less noise-sensitive. We have thus followed the two-layer approach depicted in figure 1 below. First, we reduced the 7902 vectors to 50 neurons using the SOM algorithm (abstraction level 1). Thereafter we clustered these neurons into 4-8 clusters using k -means. The SOM-generated neurons thus served as an intermediate step. Several different clusters can be generated at abstraction level 2 and to select the “best” one, we used the Davies-Bouldin index to calculate a validity score (Davies & Bouldin, 1979).

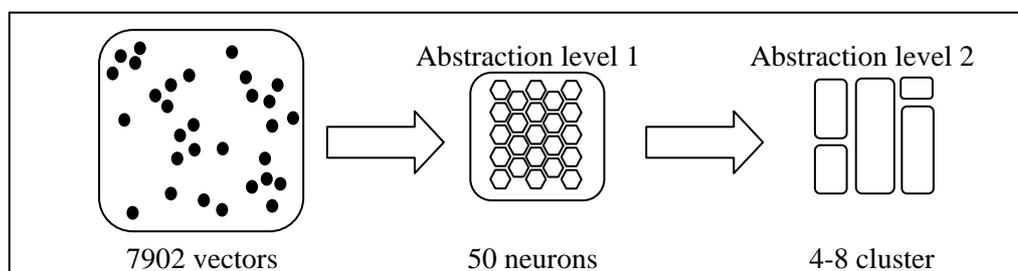


Figure 1. Going from data vectors to clusters in a two-step approach (illustration adopted from Vesanto & Alhoniemi, 2000).

When translating from a high-dimension input to a low-dimension output, two types of errors are introduced; the quantization (or projection) error and the topological error (Desmet, 2001). The quantization error (QE) is the average distance between the input layer vector and the neuron. The topological error (TE) measures the proportion of vectors for which the best matching unit, i.e., the neuron closest to the input space, is not closely related in the output layer. Desmet (2001) suggests that the choice of dimensions for the output layer of SOM has implications on the quality of the projection and has to be examined separately, as it is data dependent. We therefore calculated the QE and the TE for a number of different configurations. The result shows that the QE decreases steadily with the growing number of neurons while the TE fluctuates. Fifty neurons appeared to be a good trade-off between computational efforts required and quality of the output. As a result, a 10×5 sheet was chosen since it proved to have a lower TE value while the QE remained constant.

The final concern was to decide how many clusters to split the fifty neurons amongst. Too many clusters would not be useful from an analytic point of view so we therefore used SOM's k-means clustering feature to produce 2-8 clusters. Creating artificial borders between neurons will inevitably introduce errors. By studying the movement of the Davies-Bouldin index (see figure 2), which indicates the amount of error as a function of the number of clusters, we found a local minimum at six clusters.

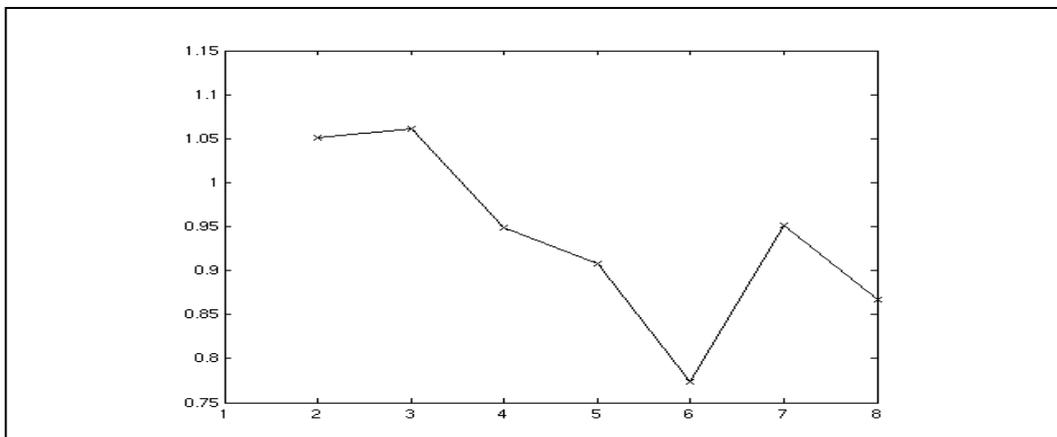


Figure 2. Error as a function of numbers of cluster (the Davies-Bouldin index (Davies & Bouldin, 1976)). Notice the local minimum at 6 clusters.

Results

In the following section we present the results received from the SOM processing of creating six clusters by first presenting the size of the clusters and thereafter account for some of the major characteristics of each cluster.

Cluster sizes

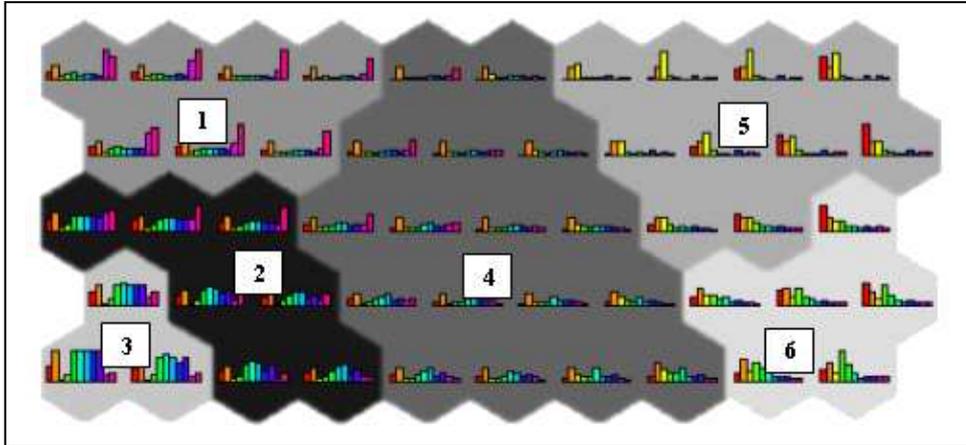


Figure 3. Cluster map with bar chart representing the ingoing vector components.

The largest cluster in terms of number of users was cluster 4 (seen in the centre of figure 3), with 32% of the users. The second largest cluster (29%) was cluster 5, which is found in the upper right side of the map in figure 3. These two clusters account for well over half of the user population. The two smallest clusters (Cluster 3 (5%) and Cluster 6 (7%)) are located in the lower left and lower right sides of the map, respectively. Being far apart in the graph means that their users have behaved very differently. Cluster 1 (18%) and Cluster 2 (9%), which together account for a quarter of the users, are co-located on the left side of the map in figure 3.

Contents of clusters

In figure 4, we show how the value of each variable varies between clusters. The X axis shows the 11 variables whereas the Y axis shows a SOM internal value representing the relative impact each variable has on the clusters. The variables are: 1) Query length, 2) Number of find similar, 3) Time examining document, 4) Time examining result page, 5) Session duration, 6) Number of queries, 7) Number of viewed hits, 8) Number of viewed result pages, 9) Number of activities, 10) Number of sessions, and 11) Number of active days.

The six clusters are represented by coloured lines (series 1 to 6). As described in section 4, each variable has been normalised.

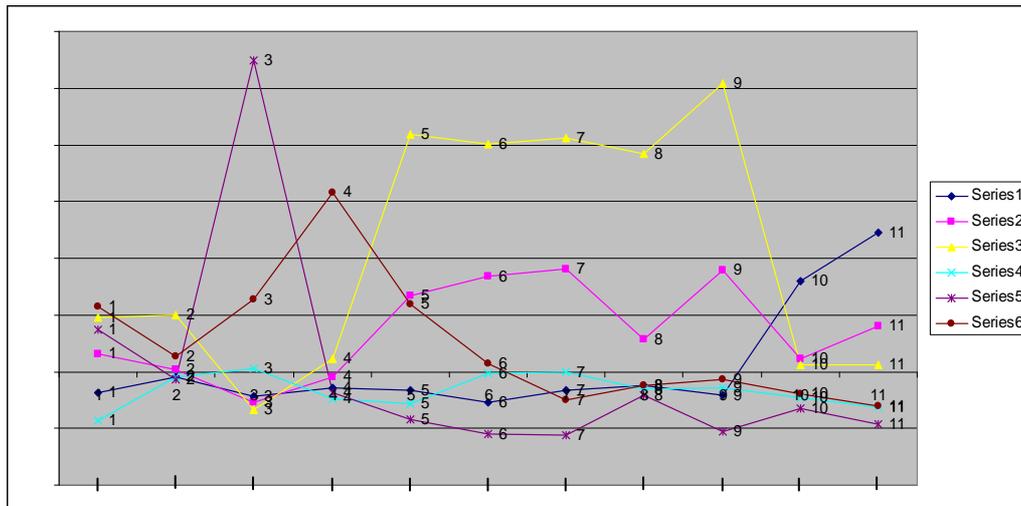


Figure 4. Fluctuation in variable values between clusters (series 1-6).

A number of interesting observations can be made from figure 4. Cluster 1 users are characterised by their frequent use; both in number of days (variable #11) and in number of sessions per day (variable #10). These users are active three days per week and return to the search engine many times during an ordinary day for short in-and-out type of queries.

Cluster 2 users are not extreme in any aspect but still have a very specific behaviour. They are few, have quite long sessions (#5), ask more questions (#6) and view more documents (#7) and result pages (#8) per session than do most users, cluster 3 users excluded. They typically visit the search engine two days per week.

Cluster 3 users are characterised by the large number of activities they engage in when using the search engine one or two days per week. Their search sessions are long (#5) and they submit many queries (#6), browse through many documents (#7), look at many result pages (#8), and make relatively frequent use of the Find similar feature (#2). However, they spend extremely little time reading each document (#3).

Cluster 4 is the largest cluster and is characterised by the fact that its users have no distinguishable characteristics. They are quite similar to cluster 1 users in that they submit short in-and-out queries and look at very few results, but they do not use the tool nearly as frequently.

Cluster 5 is the second largest clusters and it holds the users who are the least active (variables #10 and #11). Users in this segment are similar to clusters 1 and 4 users, but use the search engine only once a week and engage in very few activities when there. What distinguishes them from the other two is that they only click on one document but spend much time reading this; twice as much as any other user category (#3).

Cluster 6, finally, is one of the smallest and its users are characterised by the amount of time spent browsing through the output (#4). These users also formulate the longest queries (#1), and spend a useful amount of time reading the two or so documents they eventually chose to view (#3).

Discussion

We have argued that there is no typical intranet searcher that behaves in one typical way and it is therefore problematic to have merely one search tool with one single interface. It seems unlikely that such a setup would allow for an optimal search experience. However, it would also be impossible to let every employee have his or her own tool or his or her own interface. Is there a middle ground somewhere? We think that *clusters of similar users* may provide a feasible trade-off. In this study, six such clusters have emerged and been analysed.

Differences in variables

First, let us look at the variables in figure 4. Many of the lines are gathered near the bottom of the graph, which means that intranet searchers at TransMech overall have a low level of activity. Variable 1 and variable 2 are grouped rather closely together, indicating homogeneous behaviour for these parameters. This means that, regardless of cluster, users submit short queries (variable 1) and do not use the find similar feature (variable 2). The average number of terms used in a query was 1.45, to be compared to the approximate 2.5 terms per query reported for the public Web (Spink & Jansen, 2004).

Other variables are not as uniform. Most striking is variable 3 (time spent reading a document), which shows a huge spread where users in cluster 5 (and to some extent in cluster 6) really stand out. Also other variables show differences depending on cluster, e.g. variable 9 (no. of activities) and variable 11 (no. of active days).

Cluster content

Cluster 1 users are characterised by their frequent use. We suggest that these users are “fact seekers” or use the search engine as a navigation aid to quickly find what they look for.

Cluster 2 users are not extreme in any aspect but still have a very specific behaviour. They are few, have quite long sessions, ask more questions and view more result pages and documents per session than do most users, cluster 3 users excluded. They typically visit the search engine two days per week.

Cluster 3 users are not active often but when they are, they use the search engine heavily. This user group is small and can be described as more extreme versions of cluster 2 users. This behaviour, in combination with the short document browsing duration, suggests to us that these users are engaging in information seeking not to retrieve an “answer” but to broaden their understanding of the topic. The very process of seeking may provide the learning required to satisfy the information need.

Cluster 4 is the largest cluster and these users are quite similar to cluster 1 users in that they submit short in-and-out queries and look at very few results. Cluster 4 users use the search engine less often and less actively. One interpretation of this is that clusters 1 and 4 users have similar training (or lack thereof) but do different tasks.

What distinguishes cluster 5 users from the others is that they only click on one document but spend much time reading this; twice as much as any other user category. This could mean that they actually find what they are looking for. If so, it is probably not a simple fact but something that requires them to read the entire document.

Cluster 6 users, who spend much time examining the result pages and a fair amount of time reading documents, may be more experienced searcher collecting information (rather than simple facts) for some specific task.

Design implications

Clusters 1, 4 and 5 represent a large bunch of “casual users”; lay people with apparently little knowledge of how to search effectively. Cluster 1 users come often but do very little whereas cluster 4 users do very little and quite seldom. Both users groups appear to be retrieving facts, and would therefore benefit from high precision, but not necessarily from high recall. Cluster 5 users are also infrequent users but not necessarily fact seekers since they read their (one) document very carefully. However, they do not seem to care to wade through many result pages so these users would probably also prefer precision to recall. Together, these three clusters represent 80% of the user population at TransMech.

There is always a trade-off between precision, i.e., the fraction of retrieved documents which are relevant, and recall, i.e., the fraction of relevant documents retrieved from the collection of relevant documents within the entire collection. If one is optimised, the other one typically suffers (Buckland & Gey, 1994). Traditionally, information retrieval systems have been designed to do well on both these measures. Here we see that a majority of the users appear to be less concerned with recall, an observation that echoes previous suggestions on Web searching (Nielsen 1999). The design implication to be derived from this finding is that for many intranet users, precision in search tools can be prioritised at the expense of recall.

Although users from clusters 1, 4 and 5 are infrequent users who do not exploit the features of the search tools to their full potential, it might still be a good idea to involve members from these user categories when implementing an intranet search engine. These users will probably not expect fancy functions or ask for advanced features (since they do not seem to use them), but involving these users early in the process might help organisations understand the reasons for their low activity levels. In addition, by gaining these users' acceptance early in the implementation phase, they may be encouraged to become more effective seekers.

Also clusters 2 and 3 users show similarities; they return several times weekly and engage in quite a lot of activities. However, cluster 3 users are more active than are cluster 2 users. Both these user groups appear to favour recall over precision since it seems they are interested in a holistic view rather than an atomic answer. Since these are active searchers it can be expected that they have strong opinions on the search tools. During a development/implementation process these users – although most likely in minority – might be loud and demanding, since they know what to ask for. Organisations should keep in mind that these users are likely to represent only a small portion of the total user community. A strong voice should not allow them to marginalise the silent majority of less active searchers. However, since user groups 2 and 3 are small (and thus require fewer licenses) it may be feasible to buy them more advanced (and expensive) tools if they are considered important enough to the organisation.

Cluster 6, finally, is another small cluster, but what separates this segment from the rest is the fact that they wade through many result pages. They also spend a significant amount of time reading the documents they actually click on. If these are experienced searcher – and the use of many search terms suggest that they might be – they may also benefit from more sophisticated tools. These users may need tools that help them visualise the search results in a non-linear way; automatically clustered or categorised according to some taxonomy. Such visualisation tools could help them form an overall understanding more efficiently.

Limitations and future work

To do an analysis of this kind, it is important to collect data from an extended time period so that users are given a chance to return and repeat their behaviour – data from a single day would not work! Still, our analysis is based on users who actually visited the search engine during the measured week; a large majority of the employees did not. To understand their information needs, other methods must be applied.

Although the clusters themselves are computer-generated in an automated fashion, the decisions regarding spatial layout that we have made have affected the result. When studying figure 4 it becomes clear that adjacent cells can be quite similar whilst still being placed in different clusters. The decision where to draw

the cluster borders may thus seem arbitrary, but, as explained earlier, these decisions were informed by analysing the topological error, the quantization error, and the Davies-Bouldin index to find the “best” places to draw the borders. The six clusters that emerge out of our work all have distinguishable centroids that all have their own characteristic features. The interesting result is not whether we can find 4 or 8 clusters but the fact that there is more than one cluster and we can identify them using this approach. This means that search engine users are not a homogeneous group of stereotypes that should be treated collectively. Although we expect similar results, i.e. half a dozen distinguishable clusters of users, to be found on other intranets, the exact number is likely to be context-specific and thus vary between organisations. The decision of how many clusters to opt for should therefore carefully be analysed before running the clustering algorithm chosen.

One limiting aspect of our approach is that we have used average values in our vectors. Reporting only that two users have the same average query length may hide the fact that the variance may differ significantly between the two. What we would interpret as similar behaviour could in fact be quite different, and this is a methodological limitation. Still, deciding on a useful number of dimensions to include in the model is a delicate balancing act; a too complex model requires more processing power and may produce results that are impossible to interpret. We have suggested a level we believe is both feasible and useful but more research in this area is obviously needed.

Other clustering algorithms than the one used by us may provide different results, and we invite more research in this area. However, the focus in this paper has not been to find and use the best or most efficient clustering algorithm, but to show the feasibility of using clustering techniques to identify different groups of user behaviour.

Conclusions

In this study, we have argued that there is no typical intranet searcher that behaves in one typical way and showed that it is problematic to have merely one search tool with one single interface. Using Self-Organising Maps, we have identified and described differences between segments of information seekers in intranets, and we can thus conclude that intranet search engine users are not a homogenous group. Instead, search engine users can be split up in segments, each with their particular behaviour characteristics.

In this particular study we found six different clusters that can broadly be sorted into three different categories. The largest category, with nearly 80% of the users (consisting of clusters 1, 4 and 5), represents the “casual seekers”; lay people with apparently little knowledge of how to search effectively. Many of these appear to be “fact seekers”; users looking for quickly retrieved answers, and

this category would therefore likely benefit from having precision boosted at the expense of recall.

The second category users, with 14% of the users (consisting of clusters 2 and 3), apply a more holistic approach to information seeking and consequently have longer sessions, and more reading time. We suggest that these users would appreciate high recall and perhaps be willing to pay for this with lower precision.

The third and smallest category consists of cluster 6 users (7%). These are the information seeking savvy employees, most likely with both training and experience. They formulate longer queries and browse through more documents. Whether they prefer precision over recall or vice versa is unknown and may change from time to time.

We conclude that self-organising maps can successfully be used to find and identify clusters of search engine usage behaviour using a standard combined log file, thus reducing the manual work required. We also conclude that such cluster can be used to better understand end users interaction with search engines thus help researchers and developers provide more targeted search solutions, instead of the current one-size-fits-all search engine.

Acknowledgments

This work was supported by the Swedish Council for Working Life and Social Research (FAS) through grant #2004-1268.

References

- Baeza-Yates, R., Hurtado, C., Mendoza, M., and Dupret, G. (2005). "Modeling User Search Behavior", in *Proceedings of the Third Latin American Web Congress*, October 31-November 2, Washington, DC, IEEE Computer Society, 242-251.
- Berry, M. J. and Linoff, G. (1997). *Data mining techniques: For marketing, sales, and customer support*. John Wiley & Sons, New York, NY, USA.
- Buckland, M. and Gey, F. (1994). The relationship between Recall and Precision, *Journal of the American Society for Information Science*, Vol. 45, No. 1, 12-19
- Cooley, R., Mobasher, B. and Srivastava, J. (1997). "Web mining: Information and pattern discovery on the World Wide Web", in *Proceedings of International Conference on Tools with Artificial Intelligence*, Newport Beach, CA., 558-567.
- Cooper, A. (1999). *The inmates are running the asylum: Why high tech products drive us crazy and how to restore the sanity*, Sams: Indianapolis.
- Davies, D.L., Bouldin D.W. (1979). "A cluster separation measure", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 1(4), 224-227.
- Desmet, H. (2001). "Buying behavior study with basket analysis: pre-clustering with a Kohonen map", *European Journal of Economic and Social Systems*, 15(2), 17-30.

- Ghani, R. and Fano, A. (2002). "Building recommender systems using a knowledge base of products semantics", in *Proceedings of the Workshop on Recommendation and Personalization in E-Commerce, at the 2nd International on Adaptive Hypermedia and Adaptive Web Based Systems*, Malaga, Spain.
- He, D. and Göker, A. (2000). "Detecting session boundaries from Web user logs", in *Proceedings of the 22nd Annual Colloquium on Information Retrieval Research (ECIR)*, Sidney Sussex College, Cambridge, England.
- Huang, X., Peng, F., An, A. and Schuurmans, D. (2004). "Dynamic web log sessions identification with statistical language models", *Journal of the American Society for Information Science and Technology*, 55(13), 1290-1303.
- Jansen, B. J. (2006). "Search log analysis: What is it; what's been done; how to do it", *Library and Information Science Research*, 28(3), 407-432.
- Jansen, B. and Spink, A. (2003). "An Analysis of Web Documents Retrieved and Viewed", in *Proceedings of ICIC 2003*, Las Vegas, NE, 65-69.
- Jansen, B., Spink, A., Bateman, J. and Saracevic, T. (1998). "Real life information retrieval: A study of user queries on the web", *ACM SIGIR Forum*, 32(1), 5-17.
- Kotler, P., Armstrong, G., Cunningham, M. H. and Warren R. (1996). *Principles of Marketing*, 7th edition, Prentice-Hall.
- Li, Y. and Chung, S.M. (2005). "Text document clustering based on frequent word sequences", in *Proceedings of CIKM '05*, Bremen, Germany, Oct. 31-Nov.5, 293-294.
- Li, H., Cao, Y., Xu, J., Hu, Y., Li, S. and Meyerzon, D. (2005). "A new approach to intranet search based on information extraction", in *Proceedings of CIKM '05*, Bremen, Germany, Oct. 31-Nov.5, 460-468.
- Liu, F., Yu, C. and Meng, W. (2002). "Personalized web search by mapping user queries to categories", in *Proceedings of CIKM '02*, McLean, VA, Nov. 4-9, 558-565.
- Maarek, Y.S. and Ben-Shaul, I.Z. (1996). "Automatically organizing bookmarks per contents", *Computer Networks and ISDN Systems*, Vol. 28, 1321-1333.
- Mekhaldi, D., Lalanne, D. and Ingold, R. (2004). "Using b-modal alignment and clustering techniques for document and speech thematic segmentations", in *Proceedings of CIKM '04*, Washington, DC., Nov. 8-13, 69-77.
- Nielsen, J. (1999). "User Interface Directions for the Web", *Communications of the ACM*, Vol. 42, No. 1, 65-72.
- Silverstein C., Henzinger, M., Marais, H. and Moricz, M. (1998). "Analysis of a Very Large AltaVista Query Log", *Digital SRC Technical Note #1998-014*, October 26 1998.
- Spink, A. and Jansen, B. (2004). *Web Search: Public searching of the web*. Kluwer Academic Publisher.
- Stenmark, D. (2005). "One week with a corporate search engine: A time-based analysis of intranet information seeking", in *Proceedings of AMCIS 2005*, Omaha, Nebraska, August 11-14, 2306-2316.
- Vesanto, J. and Alhoniemi, E. (2000). "Clustering of the self-organizing map", *IEEE transactions on neural networks*, 11(3), 586-600.
- Vesanto, J., Himberg, J., Alhoniemi, E. and Parhankangas, J. (1999). "Self-organizing map in matlab: the SOM toolbox", in *Proceedings of the Matlab DSP Conference '99*, Espoo, Finland, November 16-17, 35-40.
- Wang, Y. and Kitsuregawa, M. (2003). "Evaluating contents-link coupled web page clustering for web search results", in *Proceedings of CIKM'03*, New Orleans, LA, 499-506.

Stenmark & Strindberg: One for all, and all for one?

Xue, G.-R., Zeng, H.-J., Chen, Z., Yu, Y., Ma, W.-Y, Xi, W. and Fan, W. (2004). "Optimizing web search using web click-through data", in *Proceedings of CIKM '04*, Washington, DC., Nov. 8-13, 118-126.

Young, I. M. (1990). *Justice and the Politics of Difference*. Princeton University Press.

Information Specificity in the Context of Medication Information: A Conceptual Analysis

Eeva Aarnio

Turku School of Economics, Finland

eeva.aarnio@tse.fi

Reetta Raitoharju

Turku School of Economics, Finland

reetta.raitoharju@tse.fi

Abstract. Transaction cost theory suggest asset specificity to be one of the key attributes of organization's performance. Healthcare industry is strongly an information intensive field and the sufficient supply of information is crucial for its performance. The current situation in managing medication information is problematic due to fragmented information sources and, therefore, this article provides a new theoretical view to explore this phenomenon. Identification of different forms of asset specificity provides a broad view for the current problems in managing medication information. A conceptual framework for analyzing such specificities is presented. This framework is illustrated in the context of medication information and practical implications of how to reduce information specificity in this context are provided.

Keywords. Asset specificity, Information specificity, Medication information, Healthcare industry

Introduction

The efficient use of information technology (IT) is critical to efficiently produce healthcare services (Chiasson, Reddy, Kaplan & Davidson 2006). Rapidly

emerging information technologies have proven to have remarkable benefits in the healthcare sector, such as the improved quality of care or the accessibility of information (Åkesson, Saveman & Nilsson 2006). IT adoption has also been found to relate to improved financial outcomes in the healthcare sector (Menachemi, Burkhardt, Shewchuk, Burke & Brooks 2006) not to mention the reduction of medical errors (Ball, Weaver & Abbott 2003).

However, despite the increased use of clinical information technology healthcare professionals still often have problems in finding the needed information (Reddy & Pratt 2002). For instance, Lange (1993) found in his study that nurses were using the major part of their time at the end of their shift for searching medication information (Reddy & Pratt 2002). Well-managed information is said to be one of the most important resources in clinical practice because the collection, transmission, storage, and retrieval of information are crucial for most healthcare activities. Access to information is a prerequisite for evidence-based practice and coordination of care. (Moen 2003)

It has been estimated that between 44,000 and 98,000 deaths occur in the U.S per year as a result of medical errors and that a significant number of these errors involve medication (Anderson, Ramanujam, Hensel, Anderson & Sirio 2006). To prevent medication errors, information systems (e.g. electronic medical records and computerized provider order entry systems) have been integrated with promising results (Poon, Blumenfeld, Hamann, Turchin, Graydon-Baker, McCarthy, Poikonen, Mar, Schnipper, Coley, Karson, Chueh, Van Putten, Millar, Clapp, Bhan, Meyer, Gandhi & Broverman 2006).

Because of the importance and complexity of the efficient and safe medication information management, the purpose of this article is to explore the information specificities found in the current healthcare literature. Based on the previous findings the aim is to create a conceptual framework for examining the specificity of information and use it to discuss practical information systems solutions to overcome these specificity-bound obstacles.

The paper is structured as follows: first, the research context of medication information is presented. Next, the specificity of information based on the Transaction Cost Theory is described. Following this, the specificities of knowledge, time, human and site are described in the context of medication information. Next, a conceptual framework for the specificity of information is provided. Finally, examples of practical implications to overcome the specificity-bound obstacles in the context of medication information are provided.

Medication information: research context in Finland

In Finland, electronic patient records and other information systems are already widely in use in primary care units and many special health care units are about to

start implementing them. The electronic transfer of the patient and medication data between different units has mainly been efficient but further developments are still required. At the moment, patient data systems in use vary between different hospital districts and the data transfer between them is not possible. Some of the hospital districts have recently renounced using their current patient data systems and they will try to manage without any data system that facilitates the transfer of data electronically between two different units in the hospital district. Even though the goal eventually is to collect all the patient data in one, national archive that makes it possible to create smooth service chains on the national level (Potilastietojen sähköinen superloikka 2006) the national patient and medication database is still under planning and, in the worst case, it could take years before it can be implemented efficiently (Lahti 2007). In consequence, the information is not in the right place in the right time when it comes to the smooth daily operation of internal or external transactions.

To explore this problematic area a project called “Management of medication information” was started and founded by Finnish Funding Agency for Technology and Innovation. The purpose of the project is to model and explore how medication information is currently managed and what are the main problems and bottlenecks in managing medication information. This article is part of the project and aims at conceptualizing the medication information and to form and illustrate a framework based on asset specificity. This framework will be used and further elaborated in an empirical study later in this project.

Healthcare sector is found to be an information-rich environment (Reddy & Spence 2007). A message contains information if it conveys something new that is not yet known. (Kallinikos 2006). Information can become knowledge when it forms a part of person’s or organization’s knowledge base (Choudhury & Sampler 1997). However, *knowledge is not defined by its newness* (Kallinikos 2006, p. 101).

In the healthcare literacy, there are many different medication-related terms. *Medication knowledge* is defined as the knowledge about the name of the medication, dosage and how to take it. Medication knowledge also includes high correlation with medication adherence (Burge, White, Bajorek, Bazaldua, Trevino, Albright, Wright & Cigarroa 2005). However, medication knowledge can also refer to common knowledge on certain drug, and not the personal medication regimen of the patient. The term *medical knowledge* is also sometimes used as described above (e.g. Kuperman, Bobb, Payne, Avery, Gandhi, Burns, Classen & Bates 2007). *Drug information* contains among other things information on interactions, guidelines, pregnancy warnings and nursing warnings. (Sjöborg, Bäckström, Arvidsson, Andersén-Karlsson, Blomberg, Eiermann, Eliasson, Henriksson, Jacobsson, Julander, Kaiser, Landberg, Larsson, Molin & Gustafsson 2007) Because of the variation of the term *knowledge*, in this article *medication information* is used to describe the personal medication regimen of a

patient. Medication information is defined as the generic and commercial name of the drug, the dosage and the use indication.

The specificity of information

The concept of asset specificity comes from the Transaction Cost Theory (TCT) (Williamson 1985). TCT explores the governance structures to conduct transactions. It is argued that an organization will select the alternative that minimizes the sum of the costs when choosing between producing an asset internally or by acquiring it over a market. The purpose of minimization of transaction cost is to choose governance structures that maximize the performance. (Poppo & Zenger 1998) TCT has a few key attributes, such as: the specificity of the assets, the level of uncertainty, the difficulty of assessing the performance and the frequency of the transaction (Aubert, Rivard & Patry 1996).

Asset specificity *refers to durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users* (Williamson 1985, p.55). It views an asset's fungibility rather than tangibility as traditionally in financial and managerial accounting (Ruchala 1997). Transaction-specific assets normally have no or little value outside the function for which they were designed (Ruchala 1997) and an asset is highly specific when it is durable and dedicated to a specific transaction (Aubert et al. 1996). The assets for an organization can be various, for instance, raw material, skillful personnel etc. Williamson (e.g. 1981; 1985) has identified human specificity, physical specificity, site specificity and dedicated assets as different forms of asset specificity. Other specificities defined in the literature are for instance time specificity (Malone, Yates & Benjamin 1987), procedural specificity (Zaheer & Venkatraman 1994), knowledge specificity (Choudhury & Sampler 1997) and brand capital (Lamminmaki 2005).

Traditionally, the concept of asset specificity has been used in IS research in the context of IS outsourcing (e.g. Ang & Straub 1998; Watjatrakul 2005). Besides that, the assumptions of asset specificity have been used in IS research in the context of information acquiring and use (Choudhury & Sampler 1997). While asset is restricted to specific transactions, Choudhury et al. (1997, p.28) define information specificity as *the extent to which the value of information is restricted to its use and/or acquisition by specific individuals or during specific time periods*. They use time specificity and knowledge specificity in their work to classify information specificity (Choudhury & Sampler 1997).

In the next chapters, these categories (i.e. time specificity and knowledge specificity) are further elaborated in the contexts of medical information. Furthermore, human specificity and site specificity are discussed as they are an important forms of asset specificity (Williamson 1985). As the healthcare sector is

a highly information intensive field, in many cases data acquiring and using overlap and the line between these two phases is thin. Therefore, this paper does not make difference between acquiring and using information as suggested by Choudhury and Sampler (1997).

Since the medication information is in this article regarded as an asset, knowledge specificity, time specificity, human specificity and site specificity are presented in the light of medication information. Brand names, procedural specificity, and dedicated assets are not referred to in this article because the asset discussed is information and the above mentioned specificities are not seen as the major problem when sharing the medication information. Physical specificity is embedded in the way that information can be bound to a person who is the only one possessing the information. As theoretically asset specificity refers to the transferability of assets that support certain transactions, in this paper the treatment of the patient is regarded as the transaction of the organization which is supported by the asset, in this case the medication information. It is assumed here that medication information is a hardly transferable asset that affects the medical treatment of the patient. The cost is here understood widely as all the costs that the insufficient medication information could cause for an organization. For instance, if the point of care does not have all the medication information needed for the treatment it can lead to rescheduling the appointment, unnecessary tests, or in the worst case: medical errors.

In sum, the main idea of this paper is that by reducing information specificity organizations could save in costs. These savings could, for instance, be achieved by reorganizing the structures of the organization and in the best case this could also improve the performance. Therefore, the focus of this paper is to discuss how medication information is a specific asset and how this asset specificity could be reduced by more effective information systems in order to decrease transaction costs.

Knowledge specificity in medication information

Choudhury and Sampler (1997) define information to have high knowledge specificity if it can be interpreted, acquired and used effectively only by individuals possessing specific knowledge. Specific knowledge is, according to them, possessed by a very limited number of individuals and expensive to transfer. For instance, medical knowledge possessed by a doctor is an example of scientific or technical knowledge. A doctor can process and produce information that people with no medical background cannot interpret.

Health literacy – the ability to understand and act on health information (McGray 2005 p.152) has been addressed to be one of the most pressing issues in

healthcare. Challenge is to make health information accessible regardless of background or education (McGray 2005). However, medication information is produced by and targeted to several categories of users. For instance, information about medicines can be divided into four categories (Kisilowska 2006 p. 324)

- § From research institutes and producers to doctors and pharmacists;
- § From pharmacists to doctors (or research character);
- § From pharmacies to patients;
- § Generally to the public, as a promotion material mostly

This illustrates different perspectives to medical information and the goals for which medication information can be used. Public consumers have found to have difficulties in finding, understanding and acting on health information due to their lack of domain knowledge (Zeng & Tse 2006). The mediating role of language has been recognized and it is important for instance in development of medical artificial intelligence and terminologies and nomenclatures. Management of the medical terminologies has been stated to be a critical bottleneck for knowledge-based systems to solve before entering health care practice. (Timpka 1995)

Time specificity in medication information

Time specificity, also known as temporal asset specificity, concerns situations where acquiring and using information or timing and coordination of activities are critical. There is a limited time span for the acquisition and use of information or timing and coordination of activities. The shorter the time span, the more time specific the information or activity (Lamminmaki 2005; Sampler 1998). Time specificity is widely examined in the context of medical research, where critical time windows can be found in experiments or treatment-times (e.g. Lau, Rogers & Passingham 2007; Riedel, Micheau, Lam, Roloff, Martin, Bridge, de Hoz, Poeschel, McCulloch & Morris 1999).

Time specificity in information acquisition means that *information must be acquired immediately, or very shortly, after it first originates or becomes available* (Choudhury & Sampler 1997, p.32). The problem of time specificity appears, when the needed information can be acquired only during a certain event and must be captured at the time the event occurs (Sampler 1998). Time specificity in information use is *the extent to which information loses value if not used very soon after it first becomes available* (Choudhury & Sampler 1997, p.32). The same information can be different for different users and in different contexts (Sampler 1998).

The two time specificities are also dependent on each others: the information that needs to be used immediately after it becomes available, also needs to be acquired immediately (Sampler 1998). In the context of medication information, both acquiring and using of information happen often within a very short window

of time, especially in emergency department where decisions must be made rapidly because of patients' condition and patient volume (Reddy & Spence 2007).

Human specificity in medication information

Although human specificity is related in literature to professionals who have developed job-specific knowledge and expertise (Ruchala 1997), in this article we wanted to emphasize the difference between the terms knowledge specificity and human specificity. Knowledge specificity is here understood as information related to specificity that is present if the person is not able to interpret the information. In contrast, human specificity is understood as a physical specificity; a certain person has certain information and he/she can supply it but not necessarily interpret it. Unlike knowledge specificity which is expected to be dependent on certain characteristics of people (e.g. professional knowledge) human specificity refers only to a possession of the information. As an example of human specificity related problem could be that often the discussions between a physician and a nurse about the medication of a certain patient is not reported anywhere but stays as tacit knowledge between the two (Reddy & Pratt 2002).

Also a patient him/herself can be a source of human specificity of his/her medication information. This is the case when the patient has information about his/her medication that no one else has, and he/she cannot tell the information because of his/her condition etc. Problems arise if the patient has taken; for instance, drugs bought abroad, over-the-counter drugs or some natural herbal products and he/she is the only person that can provide the information.

Site specificity in medication information

Site specificity refers to assets that are bound to a particular site (Ruchala 1997). In most cases in literacy, site specificity is presented to appear in the context of a plant situated next to the raw material or suppliers situated next to the manufactures' assembly plant. The costs of relocating the plant or supplier to serve another trading relationship are therefore high. (e.g. Lamminmaki 2005; Ruchala 1997).

Although less attention is paid to the topic in academic literacy, also information can be bound to a particular site. The problem of site specificity in the context of information could appear when the information is on paper that cannot be sent to the right place or in a data base that cannot be connected to others. The reason could be that the systems are not compatibles or that there is a discontinuation caused by power failure or similar.

In the case of medication information, the cost of "relocating" the information can be much higher than in the examples of plant and supplier; site specificity in

this case could cause lives. The risk factors related to medication information and site specificity are fragmented patient information and lack of accessibility to the allergy information that is situated somewhere else (Koppel, Metlay, Cohen, Abaluck, Localio, Kimmel & Strom 2005).

The problem of site specificity in the context of medication information will become concrete as soon as the regional data systems are not in use anymore in some hospital districts in Finland. Then the physicians in some health care centers that used to belong to the regional information systems, have to rely on fax machine and post in communication (Koskela 2007).

Conceptual framework

Figure 1 presents the conceptual framework of different forms of information specificity discussed in this article. Information specificity consists of four layers that are to some extent hierarchical. The outmost layer is *Time specificity*, which means that specificity in time is present in all the other specificities as well. Second layer is *Site specificity* which means that knowledge and human specificities are also site specific. On the other words, if information is knowledge specific it is also human specific and so forth. Therefore, it is expected that information should first and foremost be timely.

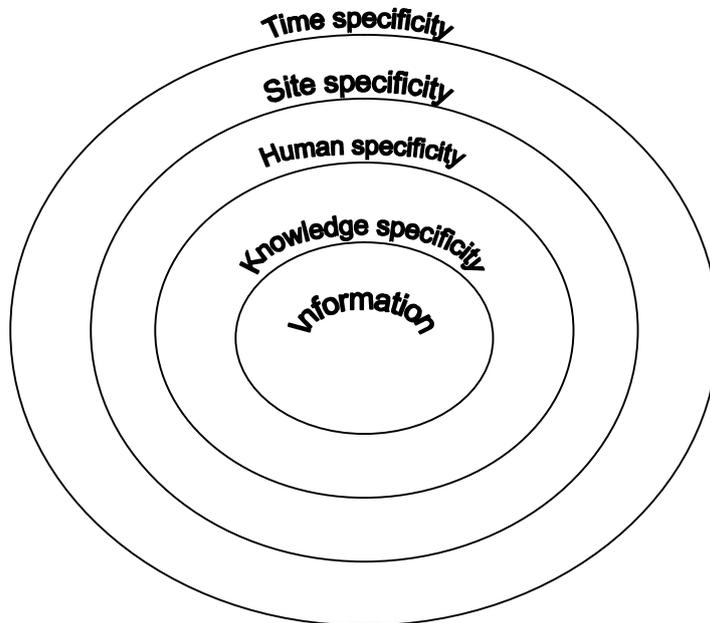


Figure 1 Conceptual framework for information specificity

Despite the hierarchical structure of information specificity, none of the layers should be ignored. However, it is assumed that as time specificity is present in all the other forms of specificities time specificity should be solved first, then site specificity and so forth. That is to say, time specificity cannot be avoided if there is knowledge, human, or site specificity present. However, usually reducing the other specificities situated “under” time specificity also reduces the time specificity. Also, if the information is knowledge or human specific, it is in some degree site specific. That is caused by the fact that moving people with essential knowledge and/or information instantly is not usually possible, or it is, or at least it should be, easier to relocate the information. Knowledge specificity is the innermost of the specificities and is therefore one of the specificities that can be eliminated more easily than the other specificities discussed in this article.

In the next chapters some examples of how to reduce these different forms of specificities are presented. These examples derive from the previous research and are chosen especially for their appropriateness in the case of Finnish healthcare system. It should, therefore, be noted that these examples are given as a way to improve the situation from the Finnish perspective.

Practical examples to reduce time specificity

Despite the amount of medication information in patient data records, the information is not in the right place in the right time without systems that make it possible. An example of time specificity could be that there is information on patient’s drug allergy in a patient data record in other hospital district’s record but it cannot be achieved because there is no way to change information. If there was information on the drug allergy, it would change the treatment of the patient completely. But, the information cannot be achieved in time because there is not any compatible information system between the two hospital districts.

As described in the conceptual framework, there is also a connection between the specificities. For instance, having a computer system to avoid the site specificity of the site-bound information also reduces time specificity. However, updating the databases does not always happen instantly but probably in a shorter window of time than relocating the information by other means.

Practical examples to reduce site specificity

Patient’s medication information and information on his/her drug allergies are often fragmented (Koppel et al. 2005). Inside a hospital or a health care centre the clinical information systems could make it possible to provide information but in a wider context, for example on the national level, medication information is still highly site specific. Nursing staff in other hospital districts than in the one patient

goes usually do not see his/her medication information in other hospital districts' information systems. Neither have the staff in pharmacies in Finland the possibility to see medications used by the patient and prescribed for him/her other than those he/she buys in that particular pharmacy.

To avoid the site specificity of medication information and information on patients' drug allergies, the information systems should be compatible in the sense that the interfaces between patient data records are standardized and that the change of information is possible. Other possibility is to create one national level database into which all the hospital districts can join in and share their information.

Practical examples to reduce human specificity

An example of patient's medication information that stays only between certain people in nursing staff is an example of human specificity (see Reddy & Spence 2007). Although the person had not the same knowledge, he/she could tell the information on the medication because he/she heard it at the scene. However, without the specific knowledge he/she could not interpret it further.

As described above, human specificity appears in the situation, where a member of the nursing staff is the only one to get certain information. This could happen for instance in the home care when a nurse visits a patient and gets new information on the patient's condition, medication etc. In this case, human specificity could be avoided by using a web-based clinical information system with handheld wireless application (see Mendonca, Chen, Stetson, McKnight, Jianbo & Cimino 2004). The information could be written down in the system and used by others instantly. Effective information sharing in its all forms is one of the key factors in avoiding human specificity, especially in small scale.

Patient is not usually seen as a health care resource, but in the case of medication information, patient can be the best informant if he/she is in the condition that allows him/her to tell about the taken/not taken medications. If that is not possible, human specificity is high. Human specificity in this case could also be avoided, if there was a database (e.g. national) where the nursing staff could see all the medications prescribed for the patient and also the medication he/she has bought from the pharmacy. However, that does not mean that patient has taken all the needed medication. For that problem, there could be a web-based health diary available for the key health care authorities where the patient could tell on his/her "own", real medication regimen (see e.g. www.adobe.com/products/flex/).

Practical examples to reduce knowledge specificity

Physicians usually have the specific knowledge to prescribe medications and if they do not know something about the drug, they can acquire the required information

with their specific knowledge for example searching in the *Pharmaca Fennica*, medication manual for physicians.

Medications often have many different indications and it is not always correctly committed to paper why a certain medication is prescribed for the patient. In that case the information stays between staff assisted at the scene, as it was in the situation in the above mentioned example (see Reddy & Spence 2007). Besides being human specific, the information is highly knowledge specific because only another physician or a person with the same knowledge could tell the indication. To avoid knowledge specificity, all the information on patient's medication should be written down shortly after acquired with all the clarifying information.

The patient him/herself does not have the needed knowledge to discover, whether the drug or the dosage prescribed for him/her is right, so the knowledge specificity of the medication information is high. However, when patient goes to a pharmacy, the pharmacist has the specific knowledge to interpret patient's prescription and he/she can eliminate the specificity and correct the wrong dosage etc. (see Kettunen 2007). Other solution could be that there was a website especially directed for citizens providing information on the drugs in understandable language.

Also a computer system could on some level interpret information, for example when a drug order entry system (DOES) with decision support gives patient and situation specific advice (e.g. Sjöborg et al. 2007). The DOES supports the knowledge by pooling the information saved in the system and the information provided by physician.

Discussion

Even though the topic has not been widely studied in the context of information related to medications or healthcare in general, the healthcare sector is full of examples of the different specificities. The specificity is present in a situation where it is difficult or even impossible to relocate the assets, for example some natural resources. However, in the healthcare sector the medication-related specificities are often such that by reorganizing the processes and investing in the information systems it would be possible to reduce them remarkably.

The potential of IS solutions to reduce specificities should be seen as one of the methods that leads to unbound information, enhanced performance and smooth service chains in the healthcare sector. Attention should be directed to studies that explore the essential reasons for information unavailability and smooth the path for designing the IS that meets the requirements.

In terms of theories, specificities based on transaction cost theory can be used to study the specificities in the context of medication information to understand the role of the nature of the information in relocating data. In terms of practical

implications, efforts toward centralized medication information databases can at the end improve the performance in healthcare sector.

References

- Anderson, J. G. - Ramanujam, R. - Hensel, D. - Anderson, M. M. - Sirio, C. A. (2006) The need for organizational change in patient safety initiatives. *International Journal of Medical Informatics* Vol. 75, No: 12, 809-817.
- Ang, S. - Straub, D. W. (1998) Production and transaction economies and IT outsourcing: A study of the U.S. banking industry. *MIS Quarterly* Vol. 22, No: 4, 535-552.
- Aubert, B. A. - Rivard, S. - Patry, M. (1996) A transaction cost approach to outsourcing behavior: Some empirical evidence. *Information & Management* Vol. 30, No: 51-64.
- Ball, M. J. - Weaver, C. - Abbott, P. A. (2003) Enabling technologies promise to revitalize the role of nursing in an era of patient safety. *International Journal of Medical Informatics* Vol. 69, No: 1, 29-38.
- Burge, Sandra - White, Darryl - Bajorek, Ellen - Bazaldua, Oralia - Trevino, Juan - Albright, Theresa - Wright, Frank - Cigarroa, Leo (2005) Correlates of Medication Knowledge and Adherence: Findings From the Residency Research Network of South Texas. *Family Medicine* Vol. 37, No: 10, 712-718.
- Chiasson, Mike - Reddy, Madhu C. - Kaplan, Bonnie - Davidson, Elizabeth (2006) Expanding multi-disciplinary approaches to healthcare information technologies: What does information systems offer medical informatics? *International Journal of Medical Informatics* Vol. Corrected proof, No:
- Choudhury, Vivek - Sampler, Jeffrey L. (1997) Information Specificity and Environmental Scanning: An Economic Perspective. *MIS Quarterly* Vol. No: March 1997,
- Kallinikos, Jannis (2006) Information out of information: on the self-referential dynamics of information growth. *Information Technology & People* Vol. 19, No: 1, 98-115.
- Kisilowska, M. (2006) Knowledge management prerequisites for building an information society in healthcare. *International Journal of Medical Informatics* Vol. 75, No: 322-329.
- Koppel, R - Metlay, JP - Cohen, A - Abaluck, B - Localio, AR - Kimmel, SE - Strom, BL (2005) Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors. *JAMA: Journal of the American Medical Association* Vol. 293, No: 10, 1197-1203.
- Koskela, Inkeri (2007) Potilastietosäihlinki alkaa helpottaa. Isot kaupungit epäröivät käytöstä väistyvän viitetietojärjestelmän kehittämistä. *Mediuutiset* 14-15
- Kuperman, Gilad J. - Bobb, Anne - Payne, Thomas H. - Avery, Anthony J. - Gandhi, Tejal K. - Burns, Gerard - Classen, David C. - Bates, David W. (2007) Medication-related Clinical Decision Support in Computerized Provider Order Entry Systems: A Review. *Journal of the American Medical Informatics Association* Vol. 14, No: 1, 29-40.
- Lahti, Jarmo (2007) Potilastietoa uhkaa vuosien tietokatkokset. Digitoday, www.digitoday.fi:
- Lamminmaki, Dawne (2005) Why do hotels outsource? An investigation using asset specificity. *International Journal of Contemporary Hospitality Management* Vol. 17, No: 6, 516-528.
- Lau, Hakwan C. - Rogers, Robert D. - Passingham, Richard E. (2007) Manipulating the Experienced Onset of Intention after Action Execution. *Journal of Cognitive Neuroscience* Vol. 19, No: 1, 81-90.
- Malone, Thomas W. - Yates, Joanne - Benjamin, Robert I. (1987) Electronic markets and electronic hierarchies. *Communications of the ACM* Vol. 30, No: 6, 484-497.
- McGray, A. T. (2005) Promoting health literacy. *Journal of the American Medical Informatics Association* Vol. 12, No: 2, 152-163.

- Menachemi, N. - Burkhardt, J. - Shewchuk, R. - Burke, D. - Brooks, G. (2006) Hospital information technology and positive financial performance: A different approach to finding an ROI. *Journal of Healthcare Management* Vol. 51, No: 1, 40-59.
- Mendonca, Eneida A. - Chen, Elizabeth S. - Stetson, Peter D. - McKnight, Lawrence K. - Jianbo, Lei - Cimino, James J. (2004) Approach to mobile information and communication for health care. *International Journal of Medical Informatics* Vol. 73, No: 631-638.
- Moen, A. (2003) A nursing perspective to design and implementation of electronic patient record systems. *Journal of Biomedical Informatics* Vol. 36, No: 375-378.
- Poon, E. G. - Blumenfeld, B. - Hamann, C. - Turchin, A. - Graydon-Baker, E. - McCarthy, P. C. - Poikonen, J. - Mar, P. - Schnipper, J. L. - Coley, C. M. - Karson, A. - Chueh, H. C. - Van Putten, C. - Millar, S. G. - Clapp, M. - Bhan, I. - Meyer, G. S. - Gandhi, T. K. - Broverman, C. A. (2006) Design and implementation of an application and associated services to support interdisciplinary medication reconciliation efforts at an integrated healthcare delivery network. *Journal of the American Medical Informatics Association* Vol. 13, No: 6, 581-592.
- Poppo, Laura - Zenger, Todd (1998) Testing alternative theories of the firm: Transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. *Strategic Management Journal* Vol. 19, No: 9, 853-877.
- Reddy, M. C. - Pratt, W. (2002) Asking questions: Information needs in a surgical intensive care unit. *American Medical Informatics Association Fall Symposium* Vol. No:
- Reddy, Madhu C. - Spence, Patricia Ruma (2007) Collaborative information seeking: A field study of a multidisciplinary patient care team. *Information Processing and Management* Vol. Article in press, No:
- Riedel, G. - Micheau, J. - Lam, A.G.M. - Roloff, E.v.L. - Martin, S.J. - Bridge, H. - de Hoz, L. - Poeschel, B. - McCulloch, J. - Morris, R.G.M (1999) Reversible neural inactivation reveals hippocampal participation in several memory processes. *Nature Neuroscience* Vol. 2, No: 10,
- Ruchala, L. V. (1997) Managing and controlling specialized assets. *Management Accounting* Vol. 79, No: 4, 20-27.
- Sampler, Jeffrey L. (1998) Redefining Industry Structure for the Information Age. *Strategic Management Journal* Vol. 19, No: 4, 343-355.
- Sjöborg, Bengt - Bäckström, Tobias - Arvidsson, Lars-Bertil - Andersén-Karlsson, Eva - Blomberg, L. Bengt - Eiermann, Birgit - Eliasson, Marie - Henriksson, Kjell - Jacobsson, Lennart - Jacobsson, Ulf - Julander, Margaretha - Kaiser, Per-Olof - Landberg, Carina - Larsson, Jonas - Molin, Björn - Gustafsson, Lars L. (2007) Design and implementation of a point-of-care computerized system for drug therapy in Stockholm metropolitan health region - Bridging the gap between knowledge and practice. *International Journal of Medical Informatics* Vol. Article in press, No:
- Timpka, T. (1995) Situated clinical cognition. *Artificial Intelligence in Medicine* Vol. 7, No: 5, 387-394.
- Watrakul, B. (2005) Determinants of IS sourcing decisions: A comparative study of transaction cost theory versus the resource-based view. *Strategic Information Systems* Vol. 14, No: 389-415.
- Williamson, O. (1981) The Economics of Organization: The Transaction Cost Approach. *American Journal of Sociology* Vol. 87, No: 3, 548-577.
- Williamson, O. (1985) *The Economic Institutions of Capitalism*. Free Press:New York
- Zaheer, Akbar - Venkatraman, N. (1994) Determinants of Electronic Integration in the Insurance Industry: An Empirical Test. *Management Science* Vol. 40, No: 5, 549-566.
- Zeng, Q. T. - Tse, T. (2006) Exploring and developing consumer health vocabularies. *Journal of the American Medical Informatics Association* Vol. 13, No: 1, 24-29.

Åkesson, K. M. - Saveman, B. I. - Nilsson, G. (2006) Health care consumers` experiences of information communication technology - A summary of literature. *International Journal of Medical Informatics* Vol. Article in press, No:

Beyond Student And Technology

Seven Pieces to Complete The E-Learning Jigsaw Puzzle in Developing Countries

Annika Andersson

Informatics/ ESI, Örebro University, Sweden

annika.andersson@esi.oru.se

Abstract. This paper presents a holistic model on facilitating and inhibiting factors for e-learning in developing countries. The question guiding this paper was: is there a model addressing all the inhibiting and facilitating factors needed to be dealt with in a developing country e-learning setting? To answer this question a comprehensive literature study on inhibiting and facilitating factors were conducted. Thirty-three factors were found belonging to seven different categories and the findings were compared to the seventeen models that the literature study also yielded. It was found that the majority of models only focus on one or a few selected factors or categories whereas findings show that exclusively looking at one category (typically the student) when discussing e-learning is not enough. E-learning consists of highly interrelated pieces of a jigsaw puzzle (including student, teacher, institution, support, course, technology and society) which are all part of a system that cannot be understood by the sum of its individual parts alone. Findings were also examined to see which factors and models (if any) are of specific importance for developing countries but it was found that most factors are universal.

Keywords. e-learning, inhibitors, facilitators, model, developing countries, literature study

Introduction

E-learning has started to make ways into the less developed part of the world and is believed to have huge potential for governments struggling to meet a growing demand for education while facing an escalating shortage of teachers (UNESCO, 2006). E-learning is seen as a tool for raising the number of students who have access to higher education by being a cheaper and more flexible alternative (Dhanarajan, 2001; Grönlund, Andersson, & Hedström, 2005; Patton, 2000; Potashnik & Capper, 1998), but challenges are plentiful. In many developing countries there is a lack of computers, electricity and skills (Dhanarajan, 2001; Evans, 2005; Grönlund, Andersson, & Hedström, 2005; Heeks, 2002; Rajesh, 2003). Other well known problems complicating the use of ICT in developing countries is the reluctance towards technology that originates from lack of experience (Wheeler & Amiotte, 2005) and another significant difficulty is that the active, participative student that is required for interactive learning is very

rare in many developing countries where the tradition is to teach in a more didactic manner (Eastmond, 2000; Evans, 2005; Rajesh, 2003; Sehrt, 2003). All these challenges need to be investigated, but considering that e-learning most often is being transferred from the developed world it is also relevant to examine the challenges facing e-learning in the developed part of the world. For one thing, drop-out rates from e-learning educations in the developed world are much higher than in traditional, classroom based, teaching (Levy, 2007; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Romiszowski, 2004; Simpson, 2004; Wheeler & Amiotte, 2005) so what would be different in a developing country setting? There are many factors contributing to e-learning success and failure but they are often hard to pinpoint so this paper will map out these and other challenges in order to see which issues need to be addressed in order to understand e-learning success and failure. In order to identify the inhibiting and facilitating factors that make e-learning successful (in the sense of making enrolled students complete the course) a literature study on inhibiting and facilitating factors for e-learning was set out. During this literature study restrictions in regard to e-learning definitions have been few; under study are all types of distance learning supported *to some extent* by *any* information and communication technology, with the only restriction to the e-learning definition that in-house classroom technology is not included (i.e. technology that is not used outside the classroom). This is due to the fact that this study focuses on gaining advantages for developing countries by overcoming the problem of distance and student quantity so at least the distance component has to be an option and part of the course.

The major research question underlying this paper thus is:

- Is there a model addressing all the inhibiting and facilitating factors needed to be dealt with in a developing country e-learning setting?

In order to answer this question there were three sub questions:

- Which are the inhibiting and facilitating factors that have an affect on e-learning?
- Which models exist addressing these factors?
- Which of these factors and models are of specific importance for developing countries?

The contribution of this paper is therefore to present a holistic model on factors that contributes to enrolment and completion of e-learning courses in developing countries.

The paper is organized as follows: First there is a presentation of the methodological approach (including selection of journals and papers and how the analysis of factors was conducted), secondly the factors found are presented and analyzed based on whether being of particular importance for developing countries. Thereafter the models found are discussed and finally a summary of findings and concluding remarks are made.

METHOD

The model is generated using the findings from a literature study which draws on 59 different papers on facilitating and inhibiting factors for e-learning. The approach has been inductive where basically all factors found have been included. The search engines used are Elin@örebro (which covers several academic databases such as ABI/Inform, Blackwell Synergy, Ebsco, ScienceDirect, SpringerLink, Wiley etc) and Google Scholar. Search words include (but are not limited to) the following: Learning, Elearning, e-learning, E-learning, eLearning, online learning, virtual learning, distance learning, distance education, enable, disable, obstacles, drop-out, retention, attrition, ICT based distance education, facilitator, inhibitor, model, successful, unsuccessful. The words have been used in different combinations and the papers have initially been selected based on title and abstract.

Selection of papers

The first search for papers yielded more than 15.000 hits but by combining the term “e-learning” with one or two of the other search words the number of hits was heavily narrowed down. From this point the first papers were selected only by title and finally the search contained 278 papers. Most of these papers were discarded because they were either highly commercial (institutes wanting to sell their own e-learning courses or software) or because they were very technical (describing different protocols or algorithms used in creating the e-learning platform). Some were rejected because they were not relevant in regard to the delimitation made on the e-learning definition (i.e. papers referring to so called “instructional technology” only used in a face-to-face classroom setting are not included) whereas some has been discarded because access entailed costs that could not be motivated when the content was unclear. Finally, at the end of the search process some articles have been left unused because there was no need to read more papers due to the fact that the factors described already had so much support in other papers. The search for papers has also been explorative in the sense that new search words were chosen on basis of key words and references used in the first chosen papers (using a snowball model) eventually making the study end up with 59 papers. These final papers were chosen based on

1. abstract and conclusions (papers addressing issues relevant for the study or new factors that have not been found in earlier papers)
2. a source (origin) check. The document has to have been accepted for a journal (paper), a conference (conference proceeding) or by a university (thesis or public report). (There has been no assessment as to the quality of the journal or conferences themselves mainly because research from developing countries tend not to be published in major reputable forums but is still wanted for this research.)
3. a validity check where the methods used to make a claim has been assessed. Cases where claims are clearly dubious, claims that are beyond what is reasonable given the method used (Grönlund, 2004) have been removed.

Analysis

By reading the abstract, result and conclusion of all the papers an extraction of quotations and statements were made. These quotations were inserted into an Access database created for this purpose where they were interpreted into factors. The database includes some 420 statements and quotations on factors that are said to have an affect on learning. These quotations were analysed and interpreted and a preliminary list of emergent factors was inserted into a column called “possible factor”. The first themes and factors thereby stem directly from the quotations. In the second turn relations and patterns were looked for in a more selective manner and another column was added called “probably final factor”. The “probably final factors” were then modelled and some factors were united into one larger category. To be nominated for the model the factor has to appear in at least two different papers – this is done in order to avoid a huge model including highly rare and specific factors. Papers were also categorized as to addressing e-learning in developed countries (industrialized countries, high income countries) or non-developed countries (transition countries, emerging economies, developing countries and least developed countries) based on the classifications made by the UN and the World Bank (UN, 2007; World Bank, 2007). The classification of papers can be seen in appendix B.

Limitations of the study

Every time a search for articles is made new papers addressing the issue are found. There is obviously much more out there and to cover the whole range of literatures will not be possible. However, the search for factors can be said to have reached a stage of theoretical saturation (Strauss & Corbin, 1998) where there are no new discoveries of factors and the same papers appear again and again. As a precaution single-occurring factors that have not been included in the model have been documented in the databases used where they are set on hold in waiting for possible reinforcement or abandonment.

A second concern is that there is an uneven distribution between papers from different countries (19 addressing transitional or developing countries and 40 addressing developed countries). The research field on e-learning in developing countries is young and there are very few quality papers or reports from any developing country at all, but despite this the database contains a dichotomised classification on statements stemming from the developed or developing world. This was made as a tool for finding possible differences between the two. Having said this, it was actually found that in regards to stated factors influencing retention and attrition they are highly universal and the same no matter what the degree of development the country is in (still bearing in mind that the reasons may have different meaning and implications in different socio-economic contexts).

A third concern is that there are many old papers used in the literature study (from turn of the millennium) which is due to the fact that the scanning of papers was deliberately open and unlimited having the intention of capturing all factors ever to be found. As it turned out, this was not such a bad idea after all, because older sources from the industrialized world seem to have a focus on problems addressed in more recent surveys from developing countries. For instance; problems of not

being familiar with technology and not used to the mode of distance are found in all countries depending on the time of introduction of e-learning.

INHIBITING AND FACILITATING FACTORS FOR E-LEARNING

The analysis yielded thirty-three factors belonging to seven categories; Student, Teacher, Technology, Support, Course, Institution and Society. It was chosen to present the categories with a jigsaw-puzzle in order to illustrate that each bit does not function separately from one another, but are interconnected and dependent on each other. Even if not all pieces of the puzzle are present one could make guesses on the outcome, but without all pieces one would not get the full picture.

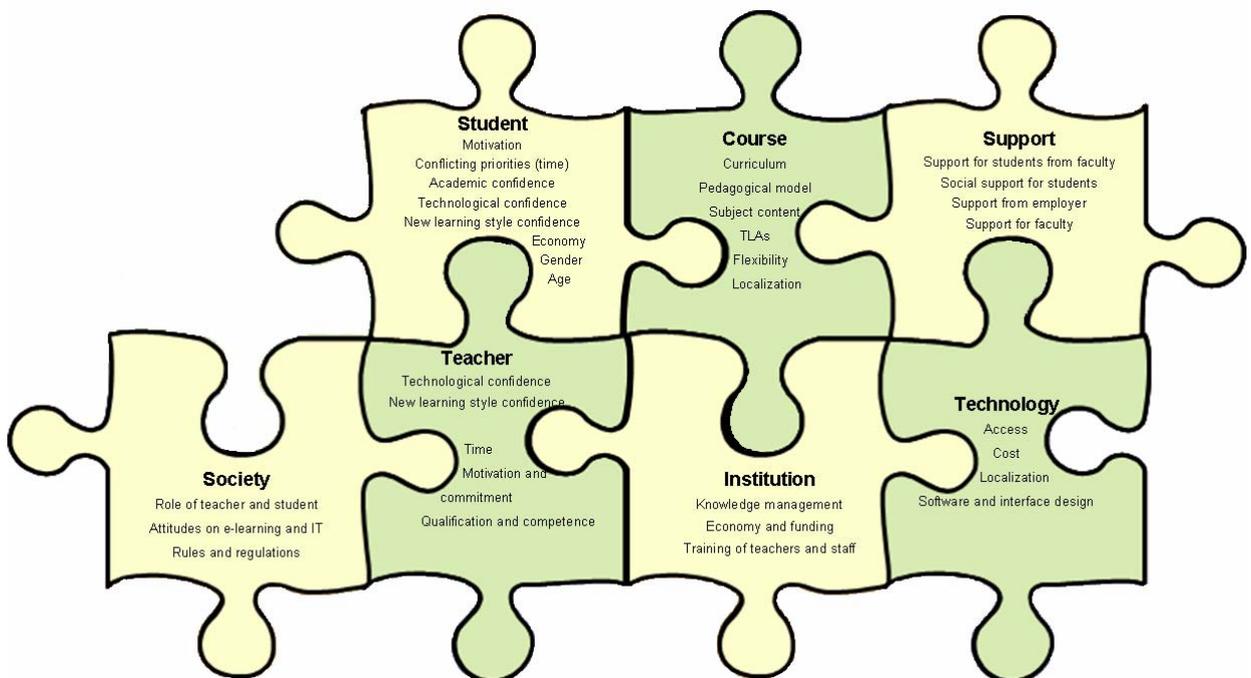


Figure 1. The jigsaw puzzle of e-learning

Description of factors

Below follows a description of the generated factors (bolded in text). References for each factor is found in the appendix, section A.

Student

This category concerns the individual student and addresses issues that affect the student in his or her learning. One of the first factors found was **motivation**. Student motivation is a factor that is frequently discussed in surveys on what affect students' satisfaction and capacity. Sometimes student motivation is described as high due to the student's goal commitment and self-efficacy and sometimes the loss of motivation is described in terms of the students having learnt what they wanted and not seeing a reason to continue. In most papers, however, the concept of motivation is not elaborated in any way; the reasons for

failure or success in the studies are simply referred to as “personal motivation” or “lack of motivation”. Another factor is **conflicting priorities (or time)** which has to do with the amount of time students have to devote to the course. Having time for learning is an important predictor of a student's learning and retention and those who study more hours are generally more successful in their studies. Students say they feel stressed and that they have big problems in arrangement of the time for the program. Problems with conflicting priorities with work and family commitment are frequently reported. A third concern is the student's **economy** and the economic prerequisites for studying. Financial difficulties and lack of student funding can be a predictor of student withdrawal. The student's **academic confidence** seems to be another good predictor of a student's success or failure in e-learning courses. According to some research academic factors such as previous academic experience and qualifications outnumber other important factors in discriminating between successful and non-successful web-based students. Academic confidence can also be about the student's self-efficacy, which is the student's confidence in his or her ability to study and successfully complete the course. The students also need some **technological confidence**; just having access to the technology is obviously not enough, the students also need to know how to use the technology; have the computer skills needed and feel confident in using computers. Lack of experience with computers can be a major hindrance for learning especially for students who are entirely new to computers whereas computer confidence accounts for much of the predictive power of good achievements. Related to the two last factors is the **new learning style confidence**. New learning style confidence is about being confident in the distance environment. Class room teaching and learning can in some cases be strongly built into the mind of teachers and students and the asynchronous approach most often used in e-learning is unfamiliar for many students. This makes them feel uncomfortable when forced to abandon the more conservative instructor-led learning style. Finally, the **age** and **gender** of the student are factors reported to make a difference in their progress.

Teacher

Another piece of the jigsaw puzzle consists of the teachers and instructors delivering the course. Just as was the case with students, the teachers confidence in using computers and other technologies, their **technological confidence** and their **new learning style confidence** affect the e-learning. Moreover the teachers and trainers level of **motivation and commitment** makes a difference. This factor concerns the teachers' motivation to teaching at a distance and their ability to see benefits by implementing e-learning in their courses. It also concerns their commitment in the e-learning classes; when teachers put little effort into giving feed-back students tend to either drop out or not pass. Finally, the teachers **qualification and competence** and the **time** available for faculty and teachers for developing and taking part in e-learning courses matters.

Technology

This piece concerns the “e” in e-learning and refers to the technological requirements. Issues discussed are which technologies are used, the costs of using

the technologies, how they are accessed and in what language they are available. The first identified factor is **access**. The use of ICT for distance education evidently makes access to the technology an enabling or disabling factor and in developing countries the issue of access is often discussed in terms of availability of so called telecentres and Internet cafés. Access refers not only to whether one has physical access to a computer and an Internet connection, but also to the reliability of the connection and the bandwidth – basically everything that is needed to access the full range of the content needed (Andersson, 2004). A second factor is the **cost** of these technologies. This factor is only discussed in developing countries where there is a need for affordable and low-cost ICT alternatives (such as television, radio and telephones) and low user charges. A third factor corresponding to the technology is the **software and interface design**. Aspects that are discussed are whether the LMS (Learning Management System) chosen supports the chosen learning model and pedagogy and that the software is easy to use (i.e. human-computer-interaction issues). Finally there is the issue of **localization**; whether the technology and software should be adapted in order to fit local culture and languages. Most research shows that localisation is of benefit for the students and the language used is often a good predictor of outcome. Localization in this case is about embedding cultural and religious values and aesthetics into the design of the technology and software.

Course

The course design and content are of major importance for e-learning. The first issue here is the **curriculum** which stipulates much of the course actions and content. There are discussions on the need to develop new curricula which is designed for an e-learning setting; thereby showing awareness that e-learning is different from traditional class-room based teaching. For one thing the choice of **pedagogical model** will have an effect on the learning. There are discussions on which pedagogical methods are appropriate for e-learning and many discussions concerns the shift from a more instructor centred approach to a learner oriented approach where the students take ownership of their learning. The **subject content** of the course also matters and refers to what is actually being taught or learned. One discusses whether the content seems interesting and relevant and if the subject content is accurate, up to date and in line with the needs of future employers. The **Teaching and Learning Activities (TLAs)** used during an actual course evidently affects e-learning and is widely discussed in the papers. Some research addresses this issue in terms of the need for interesting learning interactions or how attractive design improves learning and motivation but most research have come to explicit suggestions on what activities are needed. Activities described are frequent follow-ups, interventions from teachers and continuous assessments. Concerning the student activities we find that the choice between self studies or group work (the level of interaction with other participants) also is a factor to take into account. Much research show that students in distance mode misses social engagement and a feeling of being involved. A commonly stated reason for not passing a course or dropping out is that the student is left to self-studies, feeling alienated and isolated. Closely related to the two issues above is the level of interactivity, where research is

mostly concerned on how to enhance interactivity. Finally there is a discussion on whether the course provides hands on practice for students and training in practical skills. Another course issue is the delivery mode of the course. One talks about different levels of **flexibility** in the provided course. The factor concerns whether students should be allowed to learn at self-pace and take the examinations when they want and if they should be allowed to choose the medium of content delivery. One discusses how much personalisation that is needed for the students to be able to pass the course. This factor is often discussed in a context of the global mobility of learners where the education is not nation-bound. As was the case with technology **localization** is discussed also here. One says that there is a need for the content to consider religious beliefs, be in local language and have relevance for a local setting. Images and symbols used should be appropriate for the local culture in order to not be offensive or simply confusing.

Support

This piece of the puzzle encompasses the support systems needed. There is support from different directions and for different actors - teachers, IT experts, family and students. **Support for students by faculty** is a frequently addressed issue in the papers. Regarding this issue e-learning is very different from traditional class-room teaching where support is given and questions answered face-to face. Contact or intervention from the institution to its students and support from the tutor or other staff (including IT-support) are said to improve learning, students' satisfaction and pass rates. The support can be the institution calling up students before the course starts asking if they will attend or how he or she is progressing or just making sure there is an IT support unit for the students. The main point is to not let the student be confused and in lack of understanding. Students also need **social support** from family and friends. A stable and supportive study environment affect e-learning to a very large extent and some research even suggest that this is the most important factor influencing drop out and retention. Social support can be about the time and help the student get from family and friends (parents influence is very important here), but also about the attitudes on studying in itself; being told it is good to study and not having family members complaining about the student neglecting other duties. For those students who are working they are also in need of **support from employer**. This support can take any form from not creating barriers to learning to having mandatory company completion policies. The teachers and staff delivering the course will also need support (**support for faculty**). The level of support available for teachers and staff makes a difference where teachers generally are more motivated and committed when they feel supported by their schools. The schools can support the teachers by providing technical support, training, assistance or just showing the commitment of the institutional leaders.

Institution

Factors concerning the organisation and management of the delivering side's functions are sorted under a category labelled institution. A frequently addressed issue here is that of the organisation's **knowledge management** or knowledge

building. The factor is addressed in terms of the need to build up a knowledge repository built on research and evaluations and one discusses how important it is to share experiences from other e-learning institutions and to establish e-learning units. E-learning programs also need **economy and funding** for their activities (both in terms of human resource development and for the technology). In the papers this issue is also discussed in terms of getting return of investments and who is taking the costs for an e-learning project. Another institutional issue is to make provision for the required **training of teachers and staff**, an often neglected factor.

Society

The society in which the e-learning takes place also brings its enablers and disabler to the jigsaw puzzle. Society holds values and beliefs and one factor identified in this study is that of the **roles of teacher and student**. One writes about how the level of power distance between teacher and student affects the e-learning where power distance is a measure of the inequality between bosses and inferiors and the extent to which this is accepted (Hofstede, 1984). Research shows that in many countries children and students are taught to show respect for those older and the teacher is regarded as the expert who teaches wisdom and should not be questioned. In teaching cultures where learners act as receivers e-learning will be challenging, teacher dependency and students used to being spoon-fed are known obstacles to learning at a distance. Society also holds attitudes and relevant in this case is the **attitude on e-Learning and IT**. Politicians' attitudes can be seen in there being a political will or not towards e-learning and ICT in general. Bureaucratic hurdles due to attitudes are reported and sometimes the teachers and students themselves are questioning the credibility of e-learning courses with the perception of e-learning not being 'as good' as face to face teaching. Finally, there are **rules and regulations** affecting e-learning. Cases of governmental regulatory barriers to the introduction of ICT for learning are reported and e-learning courses are sometimes run without proper mandate from the authorities. Other issues that need dealing with are rules and regulations concerning intellectual property, copyright, filtering and censorship.

Analysis

The findings above show that factors affecting e-learning are found over a broad spectrum of categories which argues for not exclusively looking at one single category or factor when discussing e-learning success or failure. Pieces of the puzzle are also found in the surrounding society, in the management and organisation of the course, the design and delivery of the course and so forth. These findings ground for an argumentation of a holistic approach to e-learning drop-out and retention. As for contrasting the developed world against transitional and developing countries it is found that most factors are universal, however with different importance; for instance the student's economy is said to be of minor importance in well developed countries whereas in developing countries money to pay for the studies is a main worry and often the main reason for students to not fulfil their studies. Another immediate difference is seen in the factor *access* where access to technology (and telecentres) and affordable

technology solutions are highly stressed in developing countries whereas hardly mentioned in developed countries. The issue of localized technology and content is also predominant in research from transitional and developing countries which may not be surprising since these countries usually adopt “western” e-learning platforms and even courses. One factor that is never addressed by authors from developed countries is that of the roles of teacher and student – it is only discussed by author addressing developing countries. A more thorough analysis would probably yield more differences but there was no ambition in this paper on weighing each factor in detail, but it is still important to show that factors occur to a different extent depending on the economic status of the countries. Having said this, it has been made evident that all the generated factors do have a role to play in all settings and should be considered in any e-learning analysis.

MODELS ON FACTORS

Many of the issues above have been addressed by earlier research and one could question the need for another model on factors affecting e-learning. On the other hand, one argument is that the body of papers on e-learning in a global context is growing and therefore there is a need for synthesizing all relevant factors addressed by this research. Another argument is that there are very few of the existing models that take on a holistic, system approach; meaning the notion of e-learning consisting of interrelated building blocks, or pieces of a puzzle, which are all part of a system that cannot be understood by the sum of its individual parts alone. It is rather the overall system that often decides how the individual parts behave. Instead, as can be seen in the table below, the majority of models are focused on one or a few selected factors such as computer anxiety (student characteristics) or a cultural focus (societal issues).

Table 1. Focus in existing models on e-learning

Study	Focus	Student	Technology	Teacher	Institution	Society	Support	Course	d/nd*
(S. A. Brown, Fuller, & Vician, 2006)		x							d
(Burn & Thongprasert, 2005)						x			nd
(Friesner & Hart, 2004)						x			nd
(Galusha, 1998)		x		x	x		x	x	d
(Jun, 2005)		x							d
(Keller & Suzuki, 2004)		x						x	d/nd
(Kember, 1989)		x					x	x	d/nd
(Khan & Morrison, 2003; Singh, 2003)			x		x	x	x	x	d/nd

(Levy, 2007)	x							d
(Osborn, 2001)	x					x		d
(Muse, 2003)								
(Parker, 1999)	x							d
(Reeves & Reeves, 1997)	x				x	x	x	d/nd
(Sandler, 2000)	x				x		x	d
(Siritongthaworn, Krairit, Dimmitt, & Paul, 2006)	x	x	x	x	x	x	x	nd
(Tinto, 1975)	x				x	x	x	d
(Usun, 2004)			x					nd
(Wu, Tsai, Chen, & Wu, 2006)	x	x						d

* d = developed country, nd = non developed country (transition country, emerging economy, developing country and least developed country)

As can be seen from this table focus on e-learning varies and the factors addressed most commonly refer to the individual students characteristics. Another interesting discovery is how models focusing on developing countries (nd) tend to take a cultural approach. Three out of four models focusing solely on developing countries take a cultural perspective (the variable is sorted under the category society in the table above) whereas eight of the nine on developed countries have a major focus on the individual student (only one model from a developing country has this focus). Even when an explicit cultural model is not used "culture" as an explanatory factor is only addressed in papers focusing developing countries (Eastmond, 2000; Pagram, 2006). It is strange to imagine that culture would not matter in developed countries and that there is no need for researching the individual in developing countries. It could, of course, be argued that e-learning and ICT usually have inherited western values so a look at the cultural mismatch could be relevant, but when this is done on behalf of other important aspects there is a need to broaden the investigations. Even though these models are useful and provide thorough insights to certain aspects of e-learning, this paper has shown that successful e-learning depends on so many different factors (such as student skill and motivation, teacher support, and organisational arrangement etcetera) that a broader view is needed. Therefore it should be relevant to present a holistic model that is inductively generated and that encompass all different factors found at all different places of the system. Only three or four of the models above could be described as close to a system approach. Kahn has a very well-elaborated system approach with plentiful of factors. He does, however, address all issues from the delivering side's perspective (what should the delivering side do?). In his book (B. Khan, 1997) other authors address teachers and students roles and motivation but they are not included in his framework. Siritongthaworn (Siritongthaworn, Krairit, Dimmitt, & Paul, 2006) seems to cover all categories addressed in this paper, but still not all factors that the literature study yielded (for instance, factors affecting the

student mainly concerns technology acceptance). The Tinto model (Tinto, 1975) is not based on distance education students at all, but on full-time face to-face students, but is included since it has been so widely cited, tested and elaborated for distance education (Kember, 1989; Sandler, 2000; Sweet, 1986). Missing here (because it was not developed for an e-learning setting) are issues concerning technology and flexibility, but other aspects such as societal issues and attitudes are not included either.

SUMMARY OF FINDINGS

The major research question underlying this paper was: is there a model addressing all the inhibiting and facilitating factors needed to be dealt with in a developing country e-learning setting? In order to answer this question a literature study on inhibiting and facilitating factors were conducted which yielded thirty-three factors found belong to the characteristics and life situation of the student and teachers, the institutional management and organisation, different support functions, the course itself with its pedagogy and activities, the technology and the surrounding society with its values and regulations. As for existing models the literature study yielded seventeen models where the majority of models are only focused on one or a few selected factors or categories generated by the literature study. The most commonly addressed issue refers to the individual student's characteristics, but for models focusing on developing countries the spotlight is on culture. The models have different focus but since they provide thorough insights to their special field of interest their factors should all be combined to one holistic model (which has been the major contribution of this paper). Finally, there was the question on which factors and models (if any) are of specific importance for developing countries. This question has not been fully answered; while it has been shown that most factors actually are universal they do have different importance depending on the level of development the country is in. We can see that access to technology (and telecentres) and affordable technology solutions are highly stressed in developing countries (whereas hardly mentioned in developed countries) and the issue of localized technology and content is also predominant in research from transitional and developing countries. But at the same time these issues were more frequently addressed by developed countries when e-learning was new, so this paper would argue for all factors to be addressed in all contexts in order to always be on the safe side.

CONCLUSION

The major contribution of this paper has been to present a holistic model on inhibiting and facilitating factors for e-learning in developing countries. The findings argue for a holistic, system approach to e-learning where the complexity of e-learning is taken into account. E-learning consists of interrelated pieces of a jigsaw -puzzle, which are all part of a system that cannot be understood by the sum of its individual parts alone. One cannot exclusively look at one category (five of the seventeen models only addressed one of the generated categories and only one addressed all of them) when discussing e-learning success or failure. Pieces of the puzzle are also found in the surrounding society, in teacher and

student characteristics, in the support functions provided, at the institutional arrangement, in the course design and technology. Another point made in this paper is that since it has been made clear that enabling and disabling factors for e-learning are the same all over the world there is a danger in having different focus based on the economic status of the country under investigation. As shown in this paper three out of four models focusing solely on developing countries take a cultural perspective and eight of the nine on developed countries have a major focus on the individual student. For e-learning to be properly understood and developed in developing countries there is a need for broadening the models to include also the individual student characteristics and so on. The model can also be used by the researcher as a research tool for data collection and evaluation or in practice where it can be used as a check-list of factors that should be addressed when designing a project. This makes the model relevant for both research and practice by making the discussion of e-learning more sophisticated by characterizing different categories and factors for the reason of not by default taking progress in only one field.

REFERENCES

- Andersson, A. (2004). *Digital Divides Revisited - Towards a Model for Analysis 2004*. Paper presented at the DEXA eGOV 2004, Zaragoza, Spain.
- Ashby, A. (2004). Monitoring student retention in the Open University: definition, measurement, interpretation and action. *Open Learning*, 19(1), 65-78.
- Bhalalusesa, E. (2001). Supporting Women Distance Learners in Tanzania. *Open Learning*, 16(2).
- Bollag, B., & Overland, M. A. (2001). Developing Countries Turn to Distance Education. *Chronicle of Higher Education*, 47(40), A29-22.
- Bolliger, D. U. (2004). Key Factors for Determining Student Satisfaction in Online Courses. *International Journal on E-Learning*, 3(1), 61-67.
- Brown, S. A., Fuller, R. M., & Vician, C. (2006). Individual Characteristics and e-Learning: The Role of Computer Anxiety and Communication Apprehension Indiana University.
- Brown, W. R. (1999). Federal initiatives to promote access to electronic government information: The impact on the federal depository library program. *Law Library Journal*, 91(2), 291-303.
- Bruckman, A. (2002). The future of e-learning communities. *Communications of the ACM* 45(4), 60-63.
- Burn, J., & Thongprasert, N. (2005). A culture-based model for strategic implementation of virtual education delivery. *International Journal of Education and Development using Information and Communication Technology*, 1(1), 32-52.
- Chin, K. L., & Kon, P. N. (2003). *Key factors for a fully online e-learning mode: A delphi study* Paper presented at the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education, Adelaide, Australia.

- Chyung, S. Y. (2001). *Conducting Learner Analysis to Adjust Online Instruction for Your Faceless Learners*. Paper presented at the 17th Annual Conference on Distance Teaching and Learning.
- Dhanarajan, G. (2001). Distance Education: promise, performance and potential. *Open Learning, 16*(1).
- Eastmond, D. (2000). Realizing the promise of distance education in low technology countries. *Educational Technology Research and Development, 48*(2), 100-111.
- Evans, R. (2005). *Explaining low learner participation during interactive television instruction in a developing country context*. Unpublished Partial fulfilment of the requirements for a degree in Philosophiae doctor, University of Pretoria, Pretoria.
- Fozdar, B. I., Kumar, L. S., & Kannan, S. (2006). A Survey of a Study on the Reasons Responsible for Student Dropout from the Bachelor of Science Programme at Indira Gandhi National Open University. *International Review of Research in Open and Distance Learning, 7*(3).
- Frankola, K. (2001). Why Online Learners Drop Out. *Workforce, 80*(10), 52-60.
- Friesner, T., & Hart, M. (2004). A Cultural Analysis of e-Learning for China. *Electronic Journal on e-Learning 2*(1), 81-88.
- Galusha, J. M. (1998). Barriers to Learning in Distance Education. *Interpersonal Computing and Technology* Retrieved 2006-10-09, 2006
- Gammill, T., & Newman, M. (2005). Factors Associated with Faculty Use Of Web-based Instruction in Higher Education. *Journal of Agricultural Education, 46*(4).
- Govindasamy, T. (2001). Successful implementation of e-Learning Pedagogical considerations. *The Internet and Higher Education 4*(3-4), 287-299.
- Grönlund, Å. (2004). *State of the art in e-Gov research - a survey*. Paper presented at the Third International Conference, EGOV 2004, Zaragoza, Spain.
- Grönlund, Å., Andersson, A., & Hedström, K. (2005). *NextStep eGovernment in developing countries*. Örebro: Örebro University, Informatics.
- Heeks, R. (2002). Information Systems and Developing Countries: Failure, Success, and Local Improvisations. *The Information Society, 18*(2), 101-112.
- Hofstede, G. (1984). The Cultural Relativity of the Quality of Life Concept. *Academy of Management. The Academy of Management Review, 9*(3), 389-399.
- Howell, D. (2001). Elements of Effective E-Learning *College Teaching, 49*(3), 87-90.
- Jiang, M., & TING, E. (2000). A Study of Factors Influencing Students' Perceived Learning in a Web-Based Course Environment. *International Journal of Educational Telecommunications, 6*(4), 317-338.
- Jones, P., Packham, G., Miller, C., & Jones, A. (2004). An Initial Evaluation of Student Withdrawals within an e-Learning Environment: The Case of e-College Wales. *The Electronic Journal on e-Learning, 2*(1), 113-120.
- Jun, J. (2005). *Understanding Dropout of Adult Learners in E-Learning*. University of Georgia, Athens.

- Keller, J. M., & Suzuki, K. (2004). Learner motivation and E-learning design: a multinationally validated process. *Journal of Educational Media*, 29(3), 229-239.
- Kember, D. (1989). A Longitudinal-Process Model of Drop-Out from Distance Education. *The Journal of Higher Education*, 60(3), 278-301.
- Khan, B. (1997). *Web-based instruction* Englewood Cliffs, N.J: Educational Technology Publications.
- Khan, B. H. (1997). Web-Based Instruction (WBI): What Is It and Why Is It? In B. H. Khan (Ed.), *Web-Based Instruction* (pp. 5-18). New Jersey: Educational Technology Publications.
- Khan, B. H., & Morrison, J. L. (2003). The Global e-Learning Framework: An Interview with Badrul Khan. *The Technology Source*, May/June.
- Laine, L. (2003a). Is E-Learning E-ffective for IT Training? *T+D*, 57(6), 55-60.
- Laine, L. (2003b). Is E-Learning E-ffective for IT Training? *T+D*, 57(6), 55-61.
- Latchem, C., Abdullah, S., & Xinhfu, D. (1999). Open and dual-mode universities in east and south east Asia. *Performance Improvement Quarterly*, 12(2), 96-121.
- Lee, J. (2001). Instructional support for distance education and faculty motivation, commitment, satisfaction. *British Journal of Educational Technology*, 32(2), 153-160.
- Levy, Y. (2007). Comparing dropouts and persistence in e-learning courses. *Computers & Education*, 48(2), 185-205.
- Mainka, C. (2007). Putting staff first in staff development for the effective use of technology in teaching. *British Journal of Educational Technology*, 38(1), 158-161.
- Martey, A. (2004). ICT in Distance Education in Ghana. *Library hi tech news*, 21(5), 16-18.
- Mason, R., & Weller, M. (2000). Factors affecting students' satisfaction on a web course. *Australian Journal of Educational Technology*, 16(2), 173-200.
- Moller, L. (1998). Designing communities of learners for asynchronous distance education. *Educational Technology Research and Development*, 46(4), 115-122.
- Muse, H. E. (2003). The Web-based community college student: An examination of factors that lead to success and risk. *The Internet and Higher Education*, 6(3), 241-261.
- Naish, R. (2006). Not quite The Matrix yet. *E.learning Age*, 12-13.
- Neville, K., Heavin, C., & Walsh, E. (2005). A case in customizing e-learning. *Journal of Information Technology*, 20(2), 117-129.
- O'Connor, C., Sceiford, E., Wang, G., Foucar-Szocki, D., & Griffin, O. E. (2003). *Departure, Abandonment, and Dropout of E-learning: Dilemma and Solutions*: James Madison University.
- Osborn, V. (2000). *Identifying At-Risk Students: An Assessment Instrument for Distributed Learning Courses in Higher Education*. University of North Texas.
- Osborn, V. (2001). Identifying at-risk students in videoconferencing and web-based distance education. *The American Journal of Distance Education*, 15(1), 41-54.

- Pagram, P., & Pagram, J. (2006). Issues In E-Learning: A Thai Case Study. *The Electronic Journal of Information Systems in Developing Countries*, 26(6), 1-8.
- Parker, A. (1999). A study of variables that predict dropout from distance education. *International journal of educational technology*, 1(2), 1-12.
- Patton, M. A. (2000). The Importance of Being Flexible with Assignment Deadlines. *Higher Education in Europe*, 25(3), 417-423.
- Paulsen, M. F. (2003). Experiences with Learning Management Systems in 113 European Institutions. *Educational Technology & Society*, 6(4), 134-148.
- Pérez Cereijo, M. V. (2006). Attitude as Predictor of Success in Online Training. *International Journal on E-Learning*, 5(4), 623-639.
- Phillips, C., Chen, S., Kochakji, G., & Greene, K. (2004). *Why Are Online Students Dropping Out? A Needs Assessment Report*. Paper presented at the Society for Information Technology and Teacher Education International Conference.
- Potashnik, M., & Capper, J. (1998). Distance education: Growth and diversity. *Finance & Development*, 35(1), 42-45.
- Rajesh, M. (2003). A Study of the problems associated with ICT adaptability in Developing Countries in the context of Distance Education. *Turkish Online Journal of Distance Education*, 4(2).
- Reeves, T. C., & Reeves, P. M. (1997). Effective Dimensions of Interactive Learning on the World Wide Web. In B. Kahn (Ed.), *Web-based Instruction*. New Jersey: Educational Technology Publications.
- Romiszowski, A. (2004). How's the E-learning Baby? Factors Leading to Success or Failure of an Educational Technology Innovation. *Educational Technology*, 44(1), 5-27.
- Sandler, M. E. (2000). Career Decision-Making Self-Efficacy, Perceived Stress, and an Integrated Model of Student Persistence: A Structural Model of Finances, Attitudes, Behavior, and Career Development. *Research in Higher Education*, 41(5), 537-580.
- Schrum, L., & Hong, S. (2002). From the Field: Characteristics of Successful Tertiary Online Students and Strategies of Experienced Online Educators. *Education and Information Technologies*, 7(1), 5-16.
- Sehrt, M. (2003). E-learning in the Developing Countries - Digital Divide into Digital Opportunities. *UN Chronicle Online*, from <http://www.un.org/Pubs/chronicle/2003/issue4/0403p45.asp>
- Simpson, O. (2004). The impact on retention of interventions to support distance learning students. *Open Learning*, 19(1).
- Singh, H. (2003). Building Effective Blended Learning Programs. *Educational Technology* 43(6), 51-54.
- Siritongthaworn, S., Krairit, D., Dimmitt, N. J., & Paul, H. (2006). The study of e-learning technology implementation: A preliminary investigation of universities in Thailand. *Education and Information Technologies*, 11(2), 137-160.
- Strauss, A., & Corbin, J. (1998). *Basics of Qualitative Research : Techniques and Procedures for Developing Grounded Theory*: Sage Publications.

- Sweet, R. (1986). Student Drop-Out in Distance Education: An Application of Tinto's Model. *Distance Education*, 7(2), 201-213.
- Tinto, V. (1975). Dropout from Higher Education: A Theoretical Synthesis of Recent Research. *Review of Educational Research*, 45(1), 89-125.
- Totter, A., Stütz, D., & Grote, G. (2006). ICT and Schools: Identification of Factors Influencing the use of new Media in Vocational Training Schools. *The Electronic Journal of e-Learning*, 4(1), 95-102.
- UN. (2007). Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings. from <http://unstats.un.org/unsd/methods/m49/m49regin.htm>
- UNESCO. (2006). *Teachers and educational quality: monitoring global needs for 2015* (UNESCO report (statistics) No. UIS/AP/06-01). Montreal, Canada: UIS, UNESCO Institute for Statistics (UIS).
- Usun, S. (2004). Factors Affecting the Application of Information and Communication Technologies (ICT) in Distance Education. *Turkish Online Journal of Distance Education*, 5(1).
- Van Liew, R. (2006). The Secret Failures of E-Learning. from http://trainingmag.com/training/headlines/article_display.jsp?vnu_content_id=1001881910&
- Wang, Q. (2006). Quality Assurance – Best Practices for Assessing Online Programs. *International Journal on E-Learning*, 5(2), 265-274.
- Westerberg, P., & Mårald, G. (2006). Avbrott på nätutbildningar - en studie av när och varför studenter hoppar av alternativt fullföljer IT-stödda distansutbildningar. *Arbetsrapport*, from <http://www.ucer.umu.se/>
- Wheeler, S., & Amiotte, S. (2005). The Death of Distance: Documenting the Effects of Distance Education in South Dakota. *Turkish Online Journal of Distance Education*, 6(1).
- WorldBank. (2007). Country Classification. from <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20420458~menuPK:64133156~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>
- Wu, J., Tsai, R. J., Chen, C. C., & Wu, Y. (2006). An Integrative Model to Predict the Continuance Use of Electronic Learning Systems: Hints for Teaching. *International Journal on E-Learning*, 5(2).
- Yukselturk, E., & Inan, F. (2004). *Factors Affecting Online Certificate Program Dropouts*. Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2004, Washington, DC, USA.
- Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker Jay, F., Jr. (2004). Can E-Learning Replace Classroom Learning? *Association for Computing Machinery. Communications of the ACM*, 47(5), 75-79.
- Zhang, D., Zhou, L., Briggs Robert, O., & Nunamaker Jay, F., Jr. (2006). Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. *Information & Management*, 43(1), 15-27.

Note

For a full list of variables used in the different models assessed please contact the author.

Appendix A. Papers addressing each factor.

In the left column the number of papers supporting the factor is set in brackets. This is not to be regarded as an estimate of how important the factor is because the search for new papers has sometimes been stopped when the factor is supported by two papers.

Student	
Motivation (15)	(Chyung, 2001; Galusha, 1998; Jun, 2005; Keller & Suzuki, 2004; Kember, 1989; Mason & Weller, 2000; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Osborn, 2000; Parker, 1999; Reeves & Reeves, 1997; Sandler, 2000; Schrum & Hong, 2002; Westerberg & Mårald, 2006; Wheeler & Amiotte, 2005; Yukselturk & Inan, 2004)
Conflicting priorities (time) (16)	(Ashby, 2004; Bhalalusesa, 2001; Fozdar, Kumar, & Kannan, 2006; Frankola, 2001; Galusha, 1998; Jones, Packham, Miller, & Jones, 2004; Jun, 2005; Laine, 2003a; Mason & Weller, 2000; Muse, 2003; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Phillips, Chen, Kochakji, & Greene, 2004; Sandler, 2000; Schrum & Hong, 2002; Westerberg & Mårald, 2006; Yukselturk & Inan, 2004)
Economy (10)	(Bhalalusesa, 2001; Dhanarajan, 2001; Galusha, 1998; Jones, Packham, Miller, & Jones, 2004; Parker, 1999; Rajesh, 2003; Sandler, 2000; Usun, 2004; Westerberg & Mårald, 2006; Yukselturk & Inan, 2004)
Academic confidence (6)	(Kember, 1989; Levy, 2007; Muse, 2003; Osborn, 2000; Sandler, 2000; Simpson, 2004)
Technological confidence (13)	(S. A. Brown, Fuller, & Vician, 2006; Burn & Thongprasert, 2005; Chyung, 2001; Dhanarajan, 2001; Galusha, 1998; Jones, Packham, Miller, & Jones, 2004; Martey, 2004; Mason & Weller, 2000; Muse, 2003; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Osborn, 2000; Schrum & Hong, 2002; Wheeler & Amiotte, 2005; Wu, Tsai, Chen, & Wu, 2006)
New learning style confidence (10)	(Burn & Thongprasert, 2005; Chyung, 2001; Galusha, 1998; Khan & Morrison, 2003; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Pagram & Pagram, 2006; Rajesh, 2003; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Usun, 2004; Wheeler & Amiotte, 2005)
Gender	(Jun, 2005; Kember, 1989)
Age	(Kember, 1989; Muse, 2003)

Teacher	
Technological confidence (6)	(Burn & Thongprasert, 2005; Dhanarajan, 2001; Galusha, 1998; Gammill & Newman, 2005; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Totter, Stütz, & Grote, 2006)
New learning style confidence (4)	(Galusha, 1998; Khan & Morrison, 2003; Rajesh, 2003; Usun, 2004)
Motivation and commitment (8)	(Bolliger, 2004; Galusha, 1998; Gammill & Newman, 2005; Jiang & TING, 2000; Lee, 2001; Mason & Weller, 2000; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Westerberg & Mårald, 2006)
Qualification and competence (3)	(Bolliger, 2004; Mainka, 2007; Totter, Stütz, & Grote, 2006)
Time (3)	(Galusha, 1998; Gammill & Newman, 2005; Totter, Stütz, & Grote, 2006)

Course	
Curriculum (4)	(Ashby, 2004; Galusha, 1998; B. H. Khan, 1997; Wang, 2006)
Pedagogical model (9)	(Dhanarajan, 2001; Eastmond, 2000; Galusha, 1998; Govindasamy, 2001; Khan & Morrison, 2003; Reeves & Reeves, 1997; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Totter, Stütz, & Grote, 2006; Dongson Zhang, Zhao, Zhou, & Nunamaker Jay, 2004)
Subject content (7)	(Ashby, 2004; Chyung, 2001; Eastmond, 2000; Galusha, 1998; Kember, 1989) (Jones, Packham, Miller, & Jones, 2004; Khan & Morrison, 2003)
Teaching and Learning Activities (26)	(Bhalalusesa, 2001; Bolliger, 2004; Bruckman, 2002; Burn & Thongprasert, 2005; Eastmond, 2000; Evans, 2005; Fozdar, Kumar, & Kannan, 2006; Galusha, 1998; Govindasamy, 2001; Howell, 2001; Jiang & TING, 2000; Keller & Suzuki, 2004; Kember, 1989; Khan & Morrison, 2003; Laine, 2003b; Mason & Weller, 2000; Moller, 1998; Muse, 2003; Naish, 2006; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Pagram & Pagram, 2006; Reeves & Reeves, 1997; Schrum & Hong, 2002; Westerberg & Mårald, 2006; Dongson Zhang, Zhao, Zhou, & Nunamaker Jay, 2004; Dongsong Zhang, Zhou, Briggs Robert, & Nunamaker Jay, 2006)
Flexibility (7)	(Dhanarajan, 2001; Galusha, 1998; Khan & Morrison, 2003; Patton, 2000; Reeves & Reeves, 1997; Schrum & Hong, 2002; Dongson Zhang, Zhao, Zhou, & Nunamaker Jay, 2004)
Localization (3)	(Friesner & Hart, 2004; Khan & Morrison, 2003; Reeves & Reeves, 1997)

Technology	
Access (13)	(Bolliger, 2004; Burn & Thongprasert, 2005; Dhanarajan, 2001; Evans, 2005; Fozdar, Kumar, & Kannan, 2006; Galusha, 1998; Jones, Packham, Miller, & Jones, 2004; Khan & Morrison, 2003; Martey, 2004; Muse, 2003; Rajesh, 2003; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Dongson Zhang, Zhao, Zhou, & Nunamaker Jay, 2004)
Cost (6)	(Dhanarajan, 2001; Eastmond, 2000; Evans, 2005; B. Khan, 1997; Martey, 2004; Rajesh, 2003)
Software & inter-face design (5)	(Govindasamy, 2001; Khan & Morrison, 2003; Neville, Heavin, & Walsh, 2005; Paulsen, 2003; Wu, Tsai, Chen, & Wu, 2006)
Localization (8)	(Eastmond, 2000; Evans, 2005; Friesner & Hart, 2004; Khan & Morrison, 2003; Pagram & Pagram, 2006; Paulsen, 2003; Rajesh, 2003; Usun, 2004)

Support	
Support for students from faculty (13)	(Bhalalusesa, 2001; Bollag & Overland, 2001; Fozdar, Kumar, & Kannan, 2006; Galusha, 1998; Govindasamy, 2001; Jones, Packham, Miller, & Jones, 2004; Kember, 1989; Khan & Morrison, 2003; Mason & Weller, 2000; Reeves & Reeves, 1997; Simpson, 2004; Wang, 2006; Westerberg & Mårald, 2006)
Social support for students (6)	(Bhalalusesa, 2001; Osborn, 2000; Schrum & Hong, 2002) (Bruckman, 2002; Galusha, 1998; Kember, 1989; Sandler, 2000; Wheeler & Amiotte, 2005).
Support from employer (6)	(Bhalalusesa, 2001; Galusha, 1998; Kember, 1989; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Schrum & Hong, 2002; Westerberg & Mårald, 2006).
Support for faculty (5)	(Gammill & Newman, 2005; Lee, 2001) (Galusha, 1998; Khan & Morrison, 2003; Wang, 2006)

Institution	
Knowledge management (7)	(Ashby, 2004; Dhanarajan, 2001; Eastmond, 2000; Galusha, 1998; Khan & Morrison, 2003; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Wang, 2006)
Economy and funding (4)	(Dhanarajan, 2001; Eastmond, 2000; Galusha, 1998; Khan & Morrison, 2003)
Training of teachers and staff (3)	(Dhanarajan, 2001; Eastmond, 2000; Khan & Morrison, 2003)

Society	
Role of teacher and student (6)	(Burn & Thongprasert, 2005; Eastmond, 2000; Evans, 2005; Pagram & Pagram, 2006; Reeves & Reeves, 1997; Usun, 2004)
Attitudes on e-learning and IT (9)	(Eastmond, 2000; Friesner & Hart, 2004; Galusha, 1998; Gammill & Newman, 2005; Khan & Morrison, 2003; Pérez Cereijo, 2006; Rajesh, 2003; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Usun, 2004; Wheeler & Amiotte, 2005)
Rules and regulations (5)	(Dhanarajan, 2001; Friesner & Hart, 2004; Galusha, 1998; Khan & Morrison, 2003; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006)

Appendix B - Distribution of papers between developed countries and developing/emerging countries

Papers (also or only) addressing developing countries and emerging economies	(Bhalalusesa, 2001; Bollag & Overland, 2001; Burn & Thongprasert, 2005; Dhanarajan, 2001; Eastmond, 2000; Evans, 2005; Fozdar, Kumar, & Kannan, 2006; Friesner & Hart, 2004; Keller & Suzuki, 2004; Kember, 1989; B. Khan, 1997; Khan & Morrison, 2003; Martey, 2004; Pagram & Pagram, 2006; Patton, 2000; Rajesh, 2003; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006; Usun, 2004; Yukselturk & Inan, 2004)	19
Papers addressing developed countries	(Ashby, 2004; Bolliger, 2004; W. R. Brown, 1999; Bruckman, 2002; Chin & Kon, 2003; Chyung, 2001; Frankola, 2001; Galusha, 1998; Gammill & Newman, 2005; Govindasamy, 2001; Howell, 2001; Jiang & TING, 2000; Jones, Packham, Miller, & Jones, 2004; Jun, 2005; Laine, 2003a; Lee, 2001; Levy, 2007; Mainka, 2007; Mason & Weller, 2000; Moller, 1998; Muse, 2003; Naish, 2006; Neville, Heavin, & Walsh, 2005; O'Connor, Sceiford, Wang, Foucar-Szocki, & Griffin, 2003; Osborn, 2000, 2001; Parker, 1999; Paulsen, 2003; Pérez Cereijo, 2006; Phillips, Chen, Kochakji, & Greene, 2004; Sandler, 2000; Schrum & Hong, 2002; Simpson, 2004; Totter, Stütz, & Grote, 2006; Van Liew, 2006; Wang, 2006; Westerberg & Mårald, 2006; Wheeler & Amiotte, 2005; Wu, Tsai, Chen, & Wu, 2006; Dongson Zhang, Zhao, Zhou, & Nunamaker Jay, 2004)	40

Toward Planned Changes: An Activity-driven ISD Model

Irmeli Luukkonen, Marika Toivanen, Anja Mursu

Department of Computer Science, University of Kuopio, Finland
irmeli.luukkonen@cs.uku.fi, marika.toivanen@cs.uku.fi, anja.mursu@cs.uku.fi

Abstract. Changes in information systems cause changes in work practices, and the sooner plans are made for these changes, the better. To make plans, we need appropriate and sufficient information about the target as a whole. To analyze and describe the work and related information system needs, we need systemic analysis. In this paper, we describe an activity-driven ISD model for analyzing domains systemically, and two example of applying the model. Our experiences show that the model facilitates the taking into account of changes in work and in information systems at the same time. The model can be applied both in early requirements engineering and when a new system is being introduced.

Keywords. Information systems development, modeling, activity theory.

Introduction

We define an Information System (IS) as a socio-technical system that consist of both manual and computer-based artifacts (later in this paper also: information tools), and people who are using information systems either as means of work or as means of co-ordination and communication in a work activity (Mursu et al., 2007). The purpose of information systems is to facilitate and help work activities.

Information systems are developed in Information System Development (ISD) processes, including analysis, design, development, implementation and evaluation phases. Depending on the view, ISD process can be seen as a software engineering process of a software producer, or an application acquisition process

of a software user, for example. In this paper the focus is on the ISD in user organizations. There are clear guidelines and regulations for the acquisition and tender processes themselves. However, the instructions do not explain how to make good requirements specifications for new systems, or how to take into account the effects of the new systems on work practices. In addition to plain software purchase, the installation, user training and introduction of new software must be planned within the ISD process in user organizations. To carry out a successful ISD process, all the above-mentioned issues should be taken care of in the analysis phase.

The need for new Information and Communication Technology (ICT) is one of the most common sources for change at work, and ISD projects are one of the most common forms of change (Korpela et al. 2002). This means that the changes in the work also have to be planned. The basic object of analysis should be the activity system rather than the information system (Korpela et al. 2004, Kuutti 1991), since information systems, including computer-based artifacts, serve as instruments or tools for work activities (e.g. Bødker 1991). Since information systems are part of activity systems, they should be developed together, but typically they are developed separately.

Information systems designers must know the users of their systems and the work to be supported by their systems. Also, users should know what impact the new technology will have on their work. Lack of shared understanding of the work and the purpose of the software leads to the supplying of applications which do not support the work processes, with the result that the end users have to change their work processes to fit the applications. Unsuccessful introductions of new applications are due mostly to the inapplicability of technical solutions (Whittaker, 1999) or poor usability of the applications. Lack of socio-technological theories in ISD is recognized as one reason for problems in achieving shared understanding (e.g. Al-Rawas & Easterbrook, 1996; Goguen & Linde, 1993; Coughlan & Macredie, 2002).

According our definition of IS, software applications are considered to be part of IS. In the Software Engineering (SE) field the trend is to replace monolithic systems with component-based solutions (e.g. Bosh, 2000; Szypersky, 1999), which means switching from “build-in-house” to “buy-ready-made” (Garlan, 2000). The ready-made solutions are implemented to fit requirements specifications made with representative end-users, not the actual end-user who is buying the product (Minkkinen & Eerola, 2007). Typically, SE is an activity of software producers, and ISD is an activity in client organizations. Although software is supposed to be a part of IS, there is a gap between SE and ISD.

This research was carried out done in the health care domain, where information plays a big role in work, e.g. in patient information. Information System Development (ISD) has been very intensive recently also in the health care domain. In Finland, for example, the goal is to improve the interoperability

of existing Electronic Patient Record (EPR) software and use national an Electronic Health Record (EHR) by the end of 2007. When successful, electronic information systems make it possible to improve the availability of the right information with right content and format, in the right place to the right person, at the right time, and with acceptable costs. This is expected to lead to efficient health care work practices, and eventually to better health care services for patients.

Our research started with the PlugIT project on healthcare applications integration in 2001 - 2004 (see <http://www.plugin.fi/english/>) in three case studies, and continues in the ZipIT project 2004 - 2007 (see <http://www.uku.fi/zipit/english/>) with case and action studies in eight pilot cases. We have used an activity-driven research approach and participatory methods (Bødker et al., 2004), and our aim is to narrow, or “zip up”, the gap between the ISD and the work development. For this we need a model which

1. facilitates the building up of a rich and holistic picture of work activity and related IS,
2. facilitates the capturing of the information needs of different stakeholders, so that different viewpoints can be combined (to ensure that appropriate and sufficient requirements for IS are captured),
3. facilitates the understanding of the effects of new technology on work: how work development (e.g. changes in work practices) can be taken into account in ISD (to ensure the appropriateness of IS in work), and
4. which is applicable both to health care professionals and IS developers in the ISD process (to achieve shared understanding of IS in work).

Our main outcome is an activity-driven ISD model which contributes to the analysis phases in ISD processes. It is aimed at people involved in development activities, including health care clinical staff, with the aim of making it easier for them to perceive the real impact of ICT on services, and thus to improve the suitability of ICT in the work.

The activity-driven ISD model is structured with three phases and three analytical levels, and it emphasizes participatory methods in ISD processes. In this paper we present the structure of the activity-driven ISD model. The rest of this paper is organized as follows. First, we briefly present the theoretical background. Next, we describe our research settings. Then, we present the structure of the activity-driven ISD model and two case examples of its applications. Finally, we discuss the model.

Theoretical background

We base our model on Activity Theory, the ActAD framework and integrative levels of analysis. The ActAD framework provides the theoretical base for analyzing the work activity both as a whole and in detail, including information

systems as part of an activity. The integrative levels of analysis allow us to study information systems and their use from individual, group and organizational viewpoints. In our research we emphasize user participation, as in the Scandinavian approach (Bjerknes & Bratteteig, 1995). Next we present briefly the ActAD framework and the levels of analysis. (For more details of our theoretical underpinnings, see Mursu et al., 2007.)

The ActAD framework and integrative levels of analysis

The Activity Analysis and Development (ActAD) framework is based on Activity Theory (AT), which is a socio-cultural theory (e.g. Vygotsky, 1978; Leontjev, 1978). It is applied mostly in the fields of learning and education, and work development (Engeström, 1987). Since the 1980s it has also been applied in the field of IS (e.g. Kuutti, 1991; Bødker, 1991; Korpela et al., 2004), mostly in Human Computer Interaction (HCI) research (Bødker, 1991; Bertelsen et al., 2000), and also in Requirements Engineering (RE) (Toivanen et al., 2004). According to ActAD, a work activity is a systemic whole, within which several people are working on a common object in an organized way to produce a common outcome which fulfills a common goal (Korpela et al., 2000). Single activities can be joined to form a network of activities. An activity can be refined down to individual actions.

The ActAD framework and its elements are illustrated in Figure 1. The framework starts with the elements of a mediated action by an individual person (Figure 1, broken line); the subject or actor, the object of the action, the instruments or means (both mental and physical) needed for the action, and the goal (Vygotsky, 1978). In practice it almost always takes several actions by several individuals to produce any useful service or product (Figure 1, lower half). In Activity Theory, such a set of mediated actions on a shared object by a number of actors, directed by a (more or less consciously) jointly desired outcome, is called an activity (Leontiev, 1978). It is important to note that individual human actions can only be understood through the collective activity which they are a part of. Instead of bunches of uncoordinated actions, work, in practice, consists of systemic activities subordinating the actions in a purposeful way.

In addition to the instruments or the means of carrying out the individual actions, other kinds of mediating instruments – a ‘social infrastructure’ – are also needed within an activity, as emphasized by Engeström (1987). The actions need to be oriented by means of coordination and communication (Figure 1, upper half); a blueprint, division of labor, meetings, rules, etc., for instance, among a construction team.

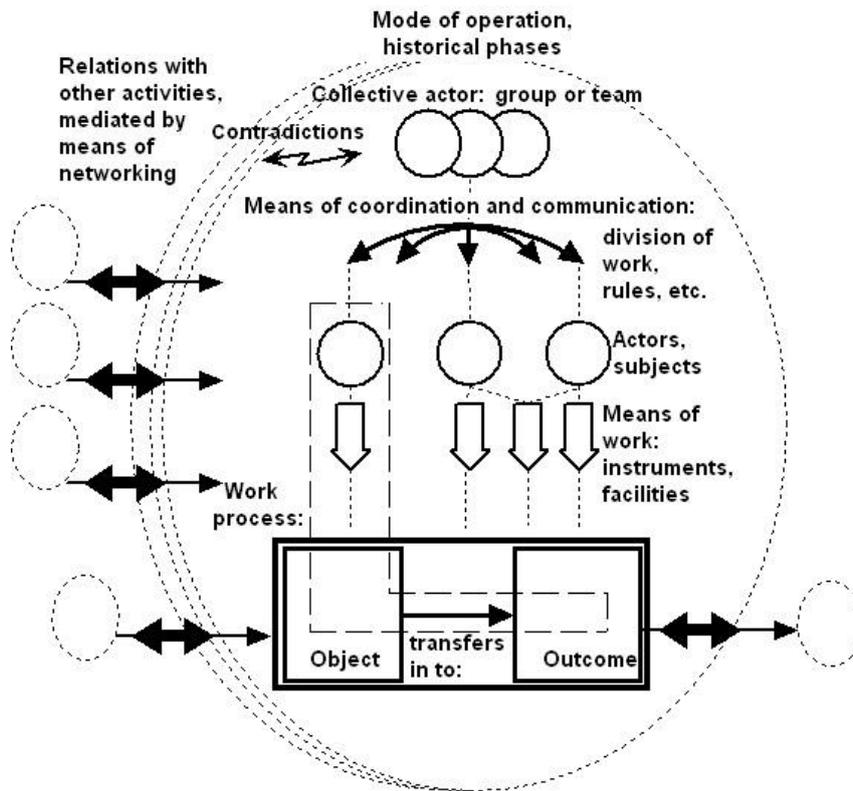


Figure 1: ActAD framework: The elements of activity (Korpela et al., 2004).

According to Engeström (1987), work activity as a real-world phenomenon is systemic by nature. There must be a relative fit between the elements of a work activity, a mode of operation (Figure 1, large oval). When an activity evolves over time, it moves from one relative fit to another, from one mode to another, in historical phases. Contradictions or an imbalance within and between various elements and the mode are the forces driving the activity to change.

Activities do not stand alone. The elements of one activity are produced by other activities, and the outcome of one activity is usually needed in one or more other activities (Figure 1, smaller ovals; Engeström, 1987). Mediation is also needed between the activities, and this is achieved by means of networking (Korpela et al., 2000). This can take place over organizational borders, and it can be in many forms, such as informational, organizational, financial, societal, and so forth. Activity Theory cannot explain these relations, but the ActAD framework helps in recognizing these relations.

As information systems are used by individuals in organizational and societal contexts, IS research should cover all the levels of analysis from the individual to the societal (Wallsham, 2000). These levels should also be integrated with each other to ensure traceability. In the model of 2x4 integrative levels of analysis

(Korpela et al, 2001), the ActAD framework is applied in four integrative levels of analysis (individual, group/activity, organizational and societal) with two viewpoints (intra and inter) on each level. All the different levels interact with each other in organizations, and influence each other. The focus of interest is a bit different at each level, but to understand the real functionality of a particular level we usually need to examine the other levels as well.

Research methodology

The activity-driven ISD model was developed and tested in the field of Finnish health care. In the ZipIT project, we have participated as researchers in eight ISD pilot cases hosted by different health care organizations and software companies. The pilot cases were situated in different phases in the organizations' ISD process, mostly in the early phases (feasibility study and requirements engineering), but also in the introduction and use of new systems. The pilot cases are depicted in Figure 2 as dashed ovals in the line of ISD process of a health care organization.

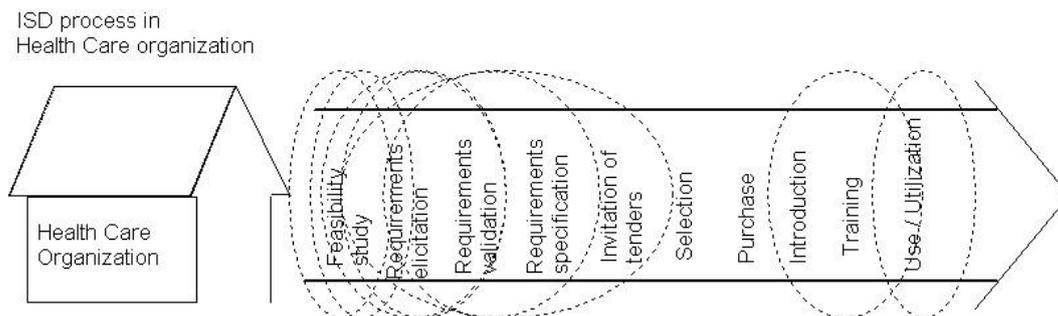


Figure 2. ZipIT pilot cases situated in an ISD process

Table 1 summarizes the kind of ISD projects we participated in. The organizations involved in each case are presented, with the staff who participated. The organizations had started their ISD projects for different reasons (Table 1, starting point and motivation), and the stakeholders had different goals in mind (Table 1, purposes). Pilot cases 1 and 2 are presented in more detail as example cases later in this paper.

Our research group consists of 3-8 full-time researchers and designers, and between one and three of us participated in each pilot case with different roles and emphases, depending on the needs of the hosting organizations. During the study, observations and experiences were discussed among the researchers and recorded in research diaries. The staff of the health care organizations played an active role in gathering information. After the pilot cases had finished, the staff in each pilot case was interviewed to elicit their opinions about the experience. We analyzed iteratively our experiences and other participants' comments in light of the

theoretical background and our earlier research results from the PlugIT project (see e.g. Toivanen et al., 2004; Minkkinen et al., 2005) and generalized the results of the analyses to formulate our model.

Table 1. Summary of pilot cases (Minkkinen et al., 2007, modified). S= software provider, M = Municipal Health Center, U = University Hospital

Pilot Case	Organizations	Participant types on the client side	Starting point, motivation	Purpose
1	M U	medical director, physician, nurse (dermatology, home care), home helper	Inadequate communication tool between organizations	Process integration between two health care organizations
2	M	physician, nurse, secretary	Old hardware and software	Fit the technical solutions to the work process
3	S U	medical director, physician, nurse	Inadequate software	Obtain new component
4	U	medical director, physician, nurse, tutor, secretary, technical support, project manager	Software already acquired	Introduction of software
5	S M	home care manager, nurse, home helper, technical support	New market area	Obtain new application
6	S M	home care manager, nurse, home helper, technical support	New market area Problems in current practice	Obtain new application
7	S U	medical director, physician, nurse, secretary, data administrator,	Decision to acquire new software	User requirements for the software acquisition process
8	M	medical director, physician, nurse, tutor	Software already acquired, not known how or why it was used (if at all)	Better usability

Activity-driven ISD model

In the activity-driven ISD model the starting point is studying the work activity as a whole, in interaction with the actors and different stakeholders, and using participatory methods. The work activity is a *systemic entity* and it is *evolving over time*. Thus we propose a two-dimensional model: one dimension for Time (Phases) and another for Description (Levels), see figure 3. The Levels express the focus of the analysis, and how detailed is the description. Phases express the flow of the process. The levels and phases are explained in more detail below.

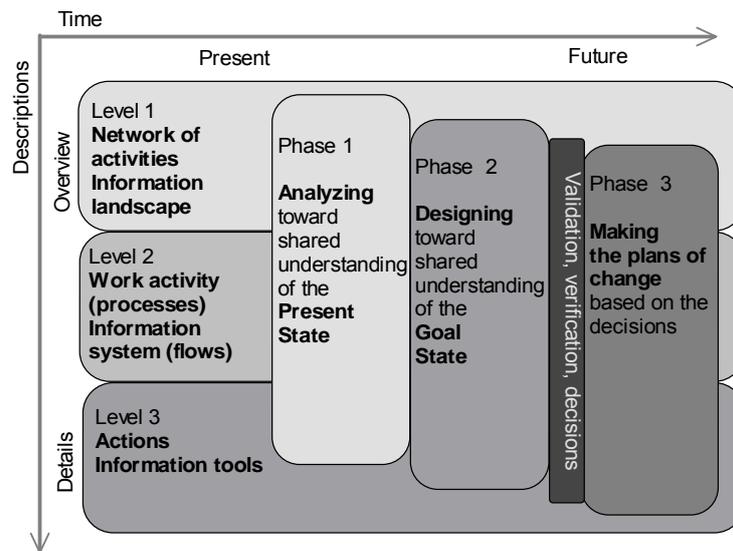


Figure 3 . The Activity-Driven ISD Model: Dimensions, Levels and Phases

Levels of the activity-driven ISD model

As a systemic entity, activity consists of elements and has a certain structure. The information system (consisting of both manual and electrical parts and the users) is one element in work activity. In systemic analysis we have to identify the elements of the activity system and be able to relate them with each other and place them in their context. We adapted Korpela et al.'s (2001) 2x4 integrative levels of analysis to the activity-driven ISD model by adopting the individual and the group/activity levels as such, and combining the organizational and societal levels into one uppermost level. Thus we have three analytical levels: (1) *networked activities and an information landscape* inside the target organization or between different organizations; (2) *work activity (processes) and an information system (data flows)* shared by cooperative workers; and (3) *individual actions and use of information tools*. The analytical levels facilitate domain structuring: “slicing” the domain into understandable pieces that are integrable

with each other. We use the ActAD framework to analyze activities in each level. The levels are shown in Figure 3 as rows.

In each level, the information system is studied in relation to the work context. By context we mean not only the physical environment such as rooms, but also the social side of work activity: rules and roles, duties and responsibilities, routines and social network, and so forth.

Information, mediated by IS, is used in all levels of the activity system: as an individual tool within actions; as a communication and coordination tool within group activity; and as a networking tool within the activity network. For example, a physician uses patient records when deciding on patient treatment (individual workflow), work in a hospital unit is organized with a roster (group activity), and a referral is used when transferring a patient from a health center to a hospital (activity network). Sometimes the same information tool plays a different role in different levels. For example, an electronic patient record (EPR) is used (1) as an *individual tool* when a nurse saves results of measurements into it; (2) as a *communication tool* when a physician checks patients' measurement records and medication in it; and (3) as a *networking tool* when a patient is transferred from one hospital unit to another which uses the same EPR.

Level 1. Activity network and information landscape

In level 1, the *activity network and information landscape* are examined in their context, to capture an overview of the domain. The central activities and interest groups involved are located in the organizational and physical context. Activities can be networked inside one organization, or between different organizations. The connections and relations between the activities constitute the network. The main parts of the IS and the main information entities are located in an activity network. We use the term *information landscape* to refer to an overview of the information system in its context. For example, applications (Electronic Patient Record, a laboratory system) and the equipment needed to use them (laptop, printer), a data network (GPRS, optical cable) and manual information tools (paper forms, notes) are parts of an information landscape. Relevant information entities such as "Referral" or "Medication information" are situated in the information landscape.

It is not reasonable to describe the entire world here, but relevant elements can be selected depending on the goal and purpose of the ISD project. For example, Figure 4 presents a simplified diagram of an activity network, where the organizations are depicted as rectangles, the central activities are depicted as ovals inside the organizations they belong to, connections between the activities are depicted with lines, and the relevant information tools (paper and data store) are drawn in their contexts. In two of the activities, the central actors are identified; a closer examination reveals that these actors may be possible informants.

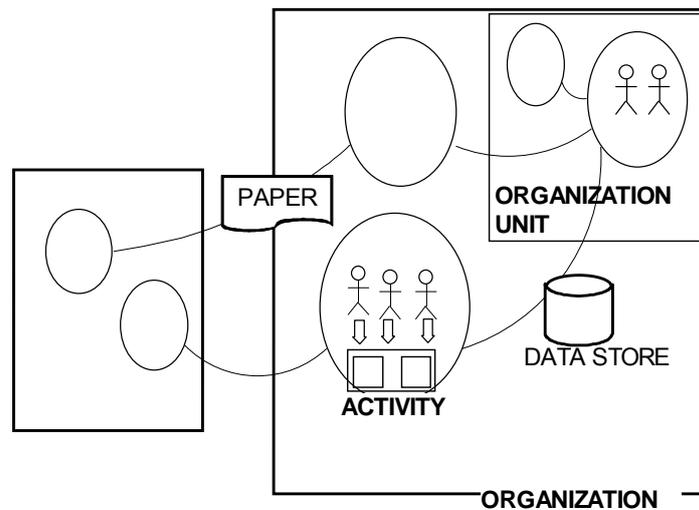


Figure 4. A simplified example of an activity network

A more detailed examination begins with drafting an overview. Guided by the purpose of our ISD process, we can zoom in on selected parts and refine the examination, usually the development points where changes are needed. The overview picture is completed in the course of this examination.

Level 2. Work activity (processes) and information system (flow).

The development points are refined in the level of *Work activity (processes) and information system (flow)*. Work processes and the information flows within them are modeled, analyzed and, if needed, re-engineered. The ActAD framework, as illustrated in Figure 1, provides a checklist of the elements of the work activity. Again, which processes or activities are selected for closer examination depends on the purpose of the ISD project.

Cooperative work processes are described with work flow diagrams. The information and information tools used in the work processes are mapped to the work flows. We use the same notation in the work flow diagram as in the activity description with the ActAD framework shown in Figure 1. For example, in Figure 5 the large rectangle represents the process, and the circles above the swim lines are the actors' participation in the process. The actions of different actors are represented with ovals in the sequences, and thin black arrows show the flow of actions. Note that the term *action* means a meaningful task, like "Make appointment", not a single act, like "Press 'submit' button". The means of action are shown with white arrows and the means of coordination and communication with curved black arrows. In addition, the inputs and outcomes are identified and mapped to the tasks. In an ISD project we pay special attention to the information and the information tools needed in the work flows and networked activities.

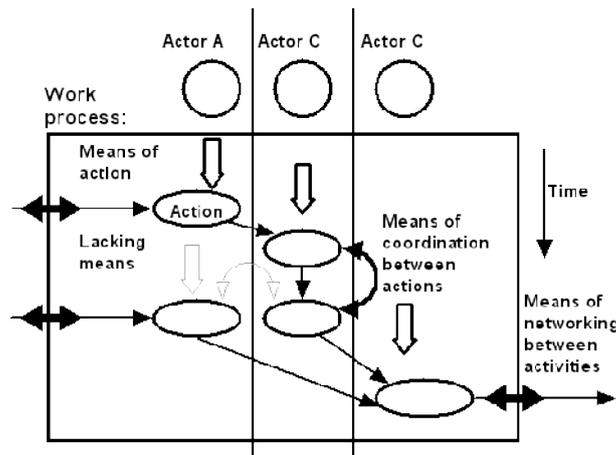


Figure 5. The notation of work flow diagram (Korpela et al. 2004)

By mapping information entities to the work processes, we identify the life cycles of information entities: where does the information originate? Who produces and saves it? Where is it saved and with what tool? Where is the information needed and by whom, and how is it available? What information is shared and by whom? The information architecture can also be described. The central information entities and their structure are examined: what is a reasonable combination of data items in each entity?

To obtain a holistic picture of the activity, we need different viewpoints on the processes: a client's service process, a worker's daily work flow, a work organization and information flows all have different aspects. Combining different viewpoints provides a better understanding than studying only one kind of process. For example, if we are modeling only daily work flows, we might miss tasks with lower frequency but which are very important to the work.

The processes described on this level should be checked on the level of activity network and information landscape to identify connections to the other processes. This is done to ensure that possible changes in one process do not have adverse effects on the other processes. The information processing tasks which were identified on this level can be refined on the next level.

Level 3. Actions and information tools

This is the level of the most detailed analysis. The focus is on individual actions and the information tools used in actions. We pay special attention to information processing in the ISD processes. Analyses are carried out to solve usability problems in existing systems, for example, or to define user needs in new ones.

The examination and design of the interaction between the actor and information tool, e.g. a computer, is important especially when defining the goal state. Drafts of user interface layouts can be used in gathering detailed

information about the information needed in each action: what data items should be immediately visible?

The individual actions are linked to the work flows, which constitute the context of information processing, in order to avoid problems in information sharing on the work activity level. We can derive Use Cases (Jacobson et al., 1992) from some of the actions in work flows and proceed to identifying software requirements.

Phases of the activity-driven ISD model

Although developing work and IS can be seen as a continuous process, in fact we can identify three phases in ISD projects (Figure 6: from left to right). To develop a work-supportive information system, both (1) *the present* and (2) *the goal* state of the work activity must be analyzed and modeled. Only then can (3) *the concrete plan* can be made to shift from the present state to the goal state. In each phase, the work activity can be studied in three levels, each having different emphases and granularity of description.

The weaknesses in the present state, i.e. the development points, are identified and related with each other in the present state description. Here, pointing out the strengths and the good practices is as important as pointing out weaknesses.

When stakeholders are considering alternative goal states, they can evaluate the effects of the new systems on their everyday work. Modeling the goal state using participatory methods allows stakeholders to share their understanding of the possibilities and the limitations of the new systems, and decide what is desirable.

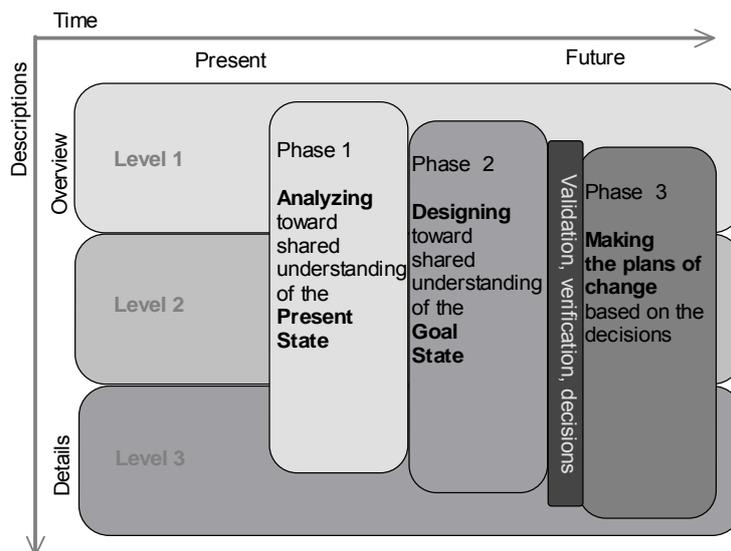


Figure 6. Phases of the activity-driven ISD model

Phase 1. Analyzing the present state

Modeling and documenting the present state of the activity makes the current situation visible. By examining present practices systemically, we can point out the weaknesses in them and the causes of the problems. Understanding the causes guides us towards possible solutions. For example, inadequate communication and cooperation may be a consequence of either *inefficient information tools* or *ambiguities in common work practices and rules*, and the solution to the communication problem would be different in each case.

Analyzing and describing the present state of an activity is one way of defining the problem space. The purpose of the present state analyses is to achieve shared understanding among different stakeholders. The present state analysis has become more and more important. Organizations have legacy systems and thus the starting point is quite complex compared with the situation in the 1970s, for example, when software engineering could start from scratch. In prevailing requirements engineering practice, the focus of analysis is the software requirements. In this model the focus of analysis is the activity system in the domain as a whole, not only the software requirements.

Phase 2. Designing iteratively toward shared understanding of the goal state

The goal state describes how the activities should be arranged after the ISD process. Designing the goal state involves considering not only alternative solutions (e.g. changes in the IS), but also their effects (changes in work processes). The designers of the goal state should ask questions such as: what realistic ways are there to improve the IS? How would the improvements affect the other elements of the activity? How does the use of a new information tool change the daily work practices, duties, and roles? Are new rules needed to organize the activities inside the organization? Customer requirements for software, including the user requirements and system requirements, are only one, albeit central, part of the goal state description.

In the real world, the introduction of a new information system often has unexpected or uncontrollable side-effects, e.g. more work and resistance to change. Designing the changes and considering their effects systemically beforehand are important in controlling the change and avoiding solutions which might be good for one individual but poor for the activity as a whole.

When designing the goal state, we are exploring the solution space. This is different from traditional software engineering in that not only the changes in the IS but also the changes in the context are considered.

Validation, verification, decisions (Figure 6, the dark column)

The results of the first and the second step must be evaluated before going on to making concrete plans for change in phase 3: are the present state and goal state descriptions correct, adequate and sufficient enough, so that plans can be made

based on them? The results should be approved throughout the organizational levels.

Phase 3. Making plans for the shift from the present to the goal

To make the path from the present to the goal state clear, both long- and short-term plans are needed. Plans answer questions such as: what acquisitions should be made? What kind of training is needed and for whom, and how should it be arranged? What other resources are needed? Designing the software is only one part of these plans.

The participants in this phase are often different from those in the previous ones. Special skills in organizational management, training, project work and software engineering, for example, are needed in this phase.

Brief guide to the use of the activity-driven ISD model

When we start analyzing the present state of an activity, we need to carefully define our objectives. The emphasis and the goals vary in different projects, and our proposal is that only the relevant phases are gone through in each project, using the relevant analytical levels.

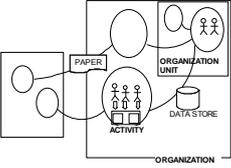
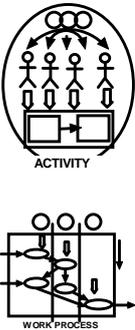
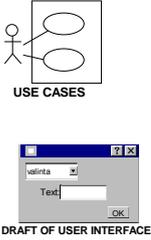
Based on the objectives, we can decide on the appropriate level of description. Although the focus can vary from the individual to the organizational level, it is necessary to move between levels to see whether changes in lower levels may influence the upper levels. The upper level of each description serves as a map, where the lower level can be traced and reflected on. So we can zoom in and out in the descriptions.

The phases do not follow each other like a waterfall, and usually it is necessary to proceed iteratively and go back to the earlier phase and reconsider some points. The project can also be restricted to the first phase if we only need to identify the problematic points in our activity in order to make decisions.

We emphasize the use of participatory methods such as multi-professional group interviews and workshops. In the ISD process it is important to understand both the technical and work aspects. Different stakeholders have their own daily work and duties, and each person describes the work process from his or her viewpoint. Discussion between the participants in workshops and elsewhere brings out tacit knowledge about the work practices. Among the challenging aspects of using participative methods are choosing the right participants, arranging time to meet (stakeholders often have full timetables), and ensuring that everyone can take part actively in discussions.

In Table 2 we present a summary of the model: the key issues of each phase at each level, some examples of possible notation in modeling, and some useful questions.

Table 2. The activity-driven ISD model in a nutshell

Phases Levels & Describing models	Analyzing toward shared understanding of the present state	Designing toward shared understanding of the goal state	Making the plans for change
<p>Network of activities & Information landscape</p> 	<p>Overview; what services or products do we produce and for whom, who are our stakeholders, what are the essential activities?</p> <p>What are the most important information entities in our activities, where are these information entities located, how do we communicate in the network, and with which tools?</p>	<p>In information system development (e.g. the introduction of new or tailored software or an integration project), we have to outline how and where change affects the network of activities and information landscape.</p> <p>Zoom out from processes and information flows to see the range of changes.</p>	<p>Considering</p> <ul style="list-style-type: none"> - context (buildings, infrastructure, legislation etc.) - changes in the network of activities and - changes in the information landscape <p>Planning</p> <ul style="list-style-type: none"> - re-organized services and activities - purchase of software and hardware
<p>Work activity (processes) & Information system (data flows)</p> 	<p>Zoom in on our essential activities: who are involved in work process, who makes decisions in different stages, how work is coordinated, what means (mental and physical) are needed in the process, what information is needed and where from, what is written down, what information tools are used?</p>	<p>In information system development (e.g. the introduction of new or tailored software or an integration project), we have to outline how and where we utilize IS in work processes, what our work processes will be like after the change, and what impact change has on the information system and data flows.</p> <p>Zoom out from the action and information tools to see the range of changes.</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Validation, verification, decisions</p> <p>Planning</p> <ul style="list-style-type: none"> - changes in the information system - changes in work processes <p>e.g. introduction of new software and new work practices step by step, unit by unit</p>
<p>Actions & Information tools</p> 	<p>Zoom in on our essential work processes, what actions need to be developed, what detailed information clusters and data items are needed in central actions. What information tools (forms etc.) are needed? We can derive use cases from the action if software is used</p>	<p>In information system development (e.g. the introduction of new or tailored software or an integration project), we have to outline how we utilize the developed IS in actions, how it would be used, and what effects the changes have on information tools. Users' needs and wishes as well as the requirements must be considered</p>	

Example cases

In the next sections, two pilot cases are described to illustrate the use of the Activity-driven ISD model. In the first case the emphasis was on analyzing the present state of an activity network and identifying points for development (phase 1 and level 1 of the model). In the second case the emphasis was on designing the goal the state of an activity (phase 2 and level 2 of the model).

Referral and referral feedback case: Information needs in the patient care chain

In this case we investigated the information needs and information flows between a health center and a hospital outpatient clinic within a care chain for treating a patient. Our multi-professional research group consisted of two nurses from outpatient clinics, a researcher from the field of Software Engineering and another from Health Policy and Management. First, we used scenarios (Alexander & Maiden, 2004) to produce common understanding inside the research group and then four focus group interviews to describe the present state and identify problematic points.

Motivation and goal

Electronic Patient Records (EPR) have recently been implemented in both the primary and secondary health care sectors. The purpose of an EPR is to improve the availability of patient information within the patient care chain. In the referral system, only physicians send referrals and referral feedback in digital form. Other information needed in patient care, such as home care instructions, is transmitted between different organizations in non-digital form. To develop digital referral and referral feedback, we need to know what patient information produced in one organization is needed in another organization and by whom, and how they get the information.

Process

First, the research group created a sketch of a patient care chain interactively. We wrote a narrative story (Alexander & Maiden, 2004) describing a care chain as a patient's path from home health care to a health center, then to the hospital outpatient clinic and finally back to home health care. This story helped us to reach a common understanding and oriented the group interviews. We also drew up drafts of the present state of referral and referral feedback, using ActAD notation (Figure 7).

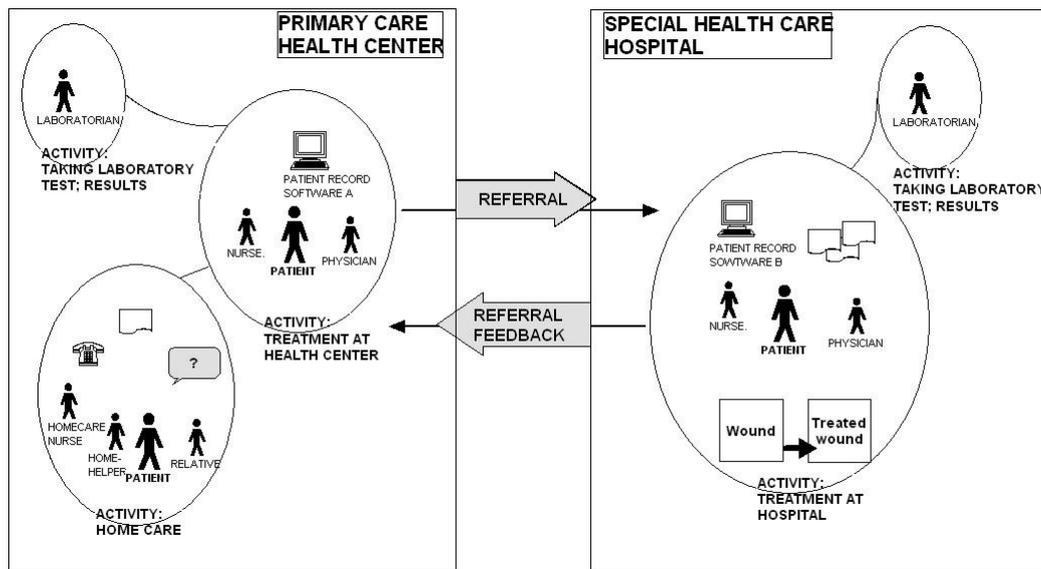


Figure 7. The present state of a network of activities and information landscape in the pilot case: referral and referral feedback.

The most important method of eliciting data was four sessions with different focus groups (clinical staff from both primary and secondary health care). In the first two sessions, we elicited the present state of the patient care chain and information needs. In the other two sessions, we investigated possible solutions and prioritization between solutions. During the workshop sessions we created a modified fishbone diagram to map the actors and their information needs along the patient care process. The diagram facilitated communication in the workshops. All sessions were recorded. After the sessions, the researchers analyzed the material.

Results

We described the present state of the patient care chain. The descriptions (Level 1) included the actors and information flows between the health care center and the hospital, and the main problems in the information flows. We found breaks in information flows between the organizations concerning medical information, laboratory test results, and radiological and other images. Some problems in the delivery and the form of the feedback were also found. Results were presented as a text and illustrated with diagrams and rich pictures (adapted from Checkland & Scholes, 2005).

Radiological department case: Considering new technical solutions for the work processes prior to purchase

In this case we investigated how replacing traditional radiological images with digital ones would affect work in the radiological department of a health care

center. We used observation to understand the present state and two future-oriented workshops (modified from future workshops, for more details see e.g. Apel, 2004) to sketch the goal state.

Motivation and goal

Digital imaging makes it possible to store radiological and other images taken in different organizations in one regional archive, so that they will be readily available to those who need and have the right to access them.

In our target area, radiological images are taken with rather old equipment, then printed on film and stored manually in different archives. In the near future, radiological images will be digitalized also in our target area. Thus it is important to estimate what changes the new technical solutions will bring to the work processes.

Process

First, to obtain a description of the present process, we took a guided tour in the radiological department. We followed an imaginary patient through the process and observed what kind of information was handled, in what form and where. The present state of the activity in the radiological department was modeled and described both in the upper level of the work activity and in more detail on the level of work processes. The descriptions were written on the basis of the tour and validated by staff in the radiological department.

Next, two full day future-oriented workshops were arranged with all the ten employees of the radiological department. During the first workshop we created visions of future work processes, sketching the situation when digitalized images are stored in a regional archive. We used patient scenarios (Alexander & Maiden, 2004) as discussion initiators in small groups divided according to profession. Work flow diagrams were used as a tool to obtain shared understanding at the workshop (Figure 8). The diagram was projected on a wall, so that participants could easily follow the discussion and suggest corrections to the diagram. In the second workshop, the alternative solutions were evaluated from the standpoint of the work processes of different professionals.



Figure 8. Workshop

Results

We described the best future work processes including the information needs from the viewpoint of the employees. The results were presented as text and illustrated with work flow diagrams complemented with rich pictures. The results are useful (i) as a basis to identify user requirements for new digital imaging equipment, and (ii) in re-organizing the work processes when new equipment is implemented.

Discussion

In this paper we present the activity-driven ISD model and two example cases of its application. This model was developed and validated iteratively in several pilot cases in the domain of Finnish health care. None of the pilot cases covered the whole model, but they were focused on different parts of the model. The model can be applied in different scales in different cases, depending on the objectives.

The model is meant to be used in both health care organizations (by work developers and data administration professionals), and software companies (by system designers and analysts). So far, we have applied the model mostly in health care organizations. The model needs further refining from the software engineering viewpoint.

The model can be used in the early phases of the ISD process, mainly in domain analysis and in requirements elicitation, and also in the introduction of new software in organizations, when new work practices and processes are planned in response to new software. The model is not meant to be a project management guide, but merely a framework: a checklist of important analysis aspects in the ISD process.

The model provides clinical staff and other stakeholders in development process with a tool to analyze the present state, design the goal state and plan the proper actions in ICT introduction. The model makes it possible to illustrate the real impact of ICT on services, and in this way to improve the suitability of ICT for the work. The model facilitates recognizing and describing different viewpoints on IS, e.g. those of different health care professionals as users, data administration, management and software producer.

The model provides a means to capture information about the work and related information system. It also provides different levels of analyses: individual actions, group activity and the activity network. Descriptions on different levels can be traced to a holistic view to see the range of planned changes, for example. Using the model, the actions of information processing can be traced to work processes, and work processes can be traced to the activity network.

Our experience shows that the following points are important. The present state of work must be understood before the goal state can be planned. An overview of work activity as a whole is needed before the software requirements are determined. Stories, rich pictures and diagrams are useful means of communication when using participatory methods. The commitment of management is essential to ensure that users are able to participate in ISD process.

This research was carried out as an action study in the health care domain and with only eight pilot cases. Future research should apply the model to other domains. In light of our experiences and the comments of our health care partners so far, we are encouraged to develop further the Activity-driven ISD model, taking into consideration software requirements and architecture.

Acknowledgments

This paper is based on research in the ZipIT project (www.uku.fi/zipit), funded by the National Technology Agency TEKES (grant no. 40426/04, 40354/05, 40252/06, 790/04, 644/05, 644/06), the Finnish Work Environment Fund (grant no. 104151), software companies and health care organizations. The authors thank all those involved in this project.

References

- Alexander, I. F. and Maiden, N. (2004). *Scenarios, stories, use cases through the systems development life-cycle*. England, John Wiley & Sons, Ltd.
- Al-Rawas, A. and Easterbrook, S. (1996). "Communication problems in requirements engineering: a field study", *Proc. 1st Westminster Conference on Professional Awareness in Software Engineering*, pp. 47-60, Royal Society, London.
- Apel, H. (2004). *The Future Workshop*. Deutsches Institut für Erwachsenenbildung. Available at http://www.die-bonn.de/esprid/dokumente/doc-2004/apel04_02.pdf. Cited: May 30th 2007.
- Bertelsen, O. W. and Bødker, S. (2000). "Introduction: Information technology in human activity", *Scandinavian Journal of Information Systems*, vol. 12, no. 1, pp 3-14.
- Bjerknes, G. and Bratteteig, T. (1995). "User participation and democracy: a discussion of Scandinavian research on system development", *Scandinavian Journal of Information Systems*, 7(1), pp. 73-98.
- Bødker, K., Kensing, F. and Simonsen, J. (2004). *Participatory IT Design. Designing for Business and Workplace Realities*. The MIT Press, Cambridge, Massachusetts London, England.
- Bødker, S. (1991). "Activity theory as a challenge to systems design", in H-E. Nissen et al. (eds.) *Information Systems Research: Contemporary Approaches and Emergent Traditions*, pp. 551-564, Elsevier, Amsterdam.
- Bosch, J. (2000). *Design and use of software architectures, Adopting and evolving a product-line approach*, Addison-Wesley.
- Checkland, P. and Scholes, J. (2005). *Soft systems methodology in action*. England, John Wiley & Sons, Ltd, A16-A19).
- Coughlan, J. and Macredie, R. D. (2002). "Effective communication in requirements elicitation: A comparison of methodologies", *Requirements Engineering*, vol. 7, no. 2, pp. 47-60.
- Engeström, Y. (1987). *Learning by Expanding*. Orienta-Konsultit Oy, Helsinki.
- Garlan, D. (2000). "Software Architecture: a Roadmap", in *Proceedings of the Conference on the Future of Software Engineering* (Limerick, Ireland, June 04 - 11, 2000). ICSE '00. pp. 91-101, ACM Press, New York.
- Goguen, J. A. and Linde, C. (1993). "Techniques for requirements elicitation", in Fickas, S. and Finkelstein, A. (eds.), *Proc. Requirements Engineering '93, IEEE Computer Society*, pp. 152-164.
- Jacobson, I., Christerson, M., Jonson, P., and Övergaard, G. (1992). *Object-oriented software engineering: A Use case driven approach*, Addison-Wesley.
- Korpela M., Mursu, A., Soriyan, A., Eerola, A., Häkkinen, H., and Toivanen, M. (2004). "IS research and development by activity analysis and development: Dead horse or the next wave?", *Relevant Theory and Informed Practice: Looking Forward from a 20-Year Perspective on IS Research*, Manchester, 15-17 July 2004, pp. 453-471, Boston, Kluwer Academic.
- Korpela, M., Mursu, A., and Soriyan, H. A. (2001). "Two times four integrative levels of analysis: a framework", in N.L. Russo, B. Fitzgerald and J. I. DeGross (eds.) *Realigning Research and Practice in Information Systems Development: The Social and Organizational Perspective*, pp. 367-377, Boston, MA: Kluwer Academic.
- Korpela, M., Mursu, A., Soriyan, H. A., and Olufokunbi, K. C. (2002), "Information systems development as an activity", *Computer Supported Cooperative Work*, vol. 11 no.1-2, 111-128.

- Korpela, M., Soriyan, H. A., and Olufokunbi, K. C. (2000). "Activity Analysis as a Method for Information Systems Development: General Introduction and Experiments from Nigeria and Finland", *Scandinavian Journal of Information Systems*, vol. 12, pp. 191-210.
- Kuutti, K. (1991). "Activity Theory and its applications to information systems research and development", in H-E. Nissen et al. (eds.) *Information Systems Research: Contemporary Approaches and Emergent Traditions*, pp. 529-549, Elsevier, Amsterdam.
- Leontiev, A. N. (1978). *Activity, Consciousness and Personality*, Prentice Hall, Englewood Cliffs NJ.
- Minkkinen I. and Eerola, A. (2007). "Improving requirements engineering from the Client's Perspective in the Health Care Domain", in Hasselbring, W. (ed.) *Proceedings of the IASTED International Conference on Software Engineering as part of the 25th IASTED International Multi-Conference on Applied Informatics*. February 13-15, 2007 Innsbruck, Austria, pp. 93-98, ACTA Press.
- Minkkinen I., Toivanen M., and Eerola A. (2005). "Importance of the approach to requirements engineering", in Husrad E, Munkvold BE, Rolland K, Flak LS, eds. *Proceedings of the 28th Information Systems Research Seminar in Scandinavia*. IRIS 28, Kristiansand, Norway, August 6-9 2005. Adger University College, 2005.
- Mursu, A., Luukkonen I., Toivanen M., and Korpela M. (2007). "Activity theory in IS research and practice - theoretical underpinnings for an ISD method", *Information Research*. Electronic Journal, 12(3) paper 311 [Available: <http://InformationR.net/ir/12-3/paper311.html>]
- Szyperski, C. (1999). *Component software*, England, Addison-Wesley.
- Toivanen, M., Häkkinen, H., Eerola, A., Korpela M., and Mursu, A. (2004). "Gathering, Structuring and Describing Information Needs in Home Care: A Method for Requirements Exploration in a 'Gray Area'", in Fieschi, M., Coiera, E., and Li, Y-C. J., (eds.) *MEDINFO 2004: Building High Performance Health Care Organizations*, San Francisco, 7-11 September, pp. 1398-1402, Amsterdam, IOS Press.
- Vygotsky, L. S. (1978). *Mind in society: The Development of Higher Psychological Processes*. Compiled from several sources and edited by Cole, M., John-Steiner, V., Scribner, S., and Souberman E., Harvard University Press, London, England.
- Walsham, G. (2000), "Globalization and IT: agenda for research", in Baskerville, R., Stage, J., DeGross, J.I. (Eds), *Organizational and Social Perspectives on Information Technology*, pp. 195-210, Boston, Kluwer Academic Publishers.
- Whittaker, B. (1999). "What went wrong? Unsuccessful information technology projects", *Information Management & Computer Security* vol. 7 no. 1, pp. 23-29.

Towards an Understanding of Trust in B2C e-Service Relationships

Matti Mäntymäki

Turku Centre for Computer Science (TUCS)

Turku School of Economics, Information Systems Science

matti.mantymaki@tse.fi

Abstract. Trust has been in the interest of Information systems (IS) and E-commerce research and viewed as one important factor influencing e-commerce adoption. Since the adoption represents only the beginning of a possible customer relationship, it can be questioned whether adoption alone is enough to understand e-customer behaviour and e-customer relationships. Encouraging customers to continue the relationship after the adoption has widely seen vital for e-businesses. This holds especially true with services where the relationship usually consists of series of transactions and interactions. Marketing literature has traditionally been interested in customer relationships and customer loyalty but seemed trust as a unitary construct, whereas IS and E-commerce have acknowledged the multi-dimensional nature of trust. This paper scrutinizes literature on IS, E-Commerce and consumer behavior to provide first steps for a more comprehensive understanding on role of trust in customer relationships, particularly customer loyalty in B2C e-services. The key findings of the study are: 1. only few studies discuss the role of trust in post-adoption phase of B2C e-services 2. in this literature trust is viewed as a monolith, 3. several background theories are applied, 4. quantitative research methods dominate the field. These findings are discussed and avenues for further research are suggested.

Keywords. Trust, customer loyalty, e-services

Introduction

Customer loyalty is viewed as one of the most important factors for e-business' success. (see. e.g. Anderson & Srinivasan 2003; Reicheld & Schefter, 2000, Verona & Prandelli, 2002; Balabanis et al., 2006; Reicheld et al., 2000; Shankar et al., 2003; Semeijin et al., 2005; Grewal et al., 2003; Thatcher & George, 2004.) The importance of customer loyalty has been widely acknowledged and discussed in marketing literature. (see e.g. Oliver, 1997; 1999; Copeland, 1923; Jacoby & Chestnut, 1978; Curasi & Kennedy, 2002; Kumar & Shah, 2004; Mittal & Lassar, 1998.) Within the information systems (IS) discipline, interest toward customer loyalty in the context of e-business has not been as extensive, despite a sufficient level of customer loyalty is seen, referring to abovementioned studies, as an important success factor but also as a prerequisite for survival (Reicheld & Schefter, 2000). Recently also IS research has started to show increasing interest toward loyalty (Otim & Grover, 2006).

Concept of trust has been in the interest of both marketing and information system disciplines and its central role has been widely acknowledged (see e.g. Morgan & Hunt, 1994; Garbarino & Johnson, 1999; Salam et al., 2005; Flavián et al. 2006; Gefen & Straub, 2004; Ba & Pavlou 2006; Pavlou & Fygenson, 2006). As Pavlou and Fygenson (2006, 133) concluded in their study on B2C e-commerce, trust is perhaps the most interesting and empirically influential belief associated with getting information and purchasing products. The emergence of e-commerce has amplified the interest to trust but its relevance is not restricted to e-environment. Trust has traditionally had an imperative role in several 'traditional' industries such as banking, air transport and health care.

Despite a considerable number of studies on trust and customer loyalty, only a relatively limited amount of literature has discussed these issues within electronic services. (See e.g. Otim & Grover, 2006; Luarn & Lin, 2003; Cyr et al., 2007.) In the IS area, the role trust has been discussed rather extensively in related to adoption behaviors. (Li et al., 2006; Hoffman et al, 1999; Pavlou & Fygenson, 2006; Wang & Head, 2007). Thus, the role of trust after the adoption has not this far drawn substantial interest within IS. Hence, this paper strives to contribute the academic discussion in the area by merging to topics, trust and customer loyalty, and hence the findings from two research streams to increase awareness of the role of trust in customer loyalty in the context of business-to-consumer e-services.

Several studies have reported a correlation between trust and loyalty, some even viewing that trust as an antecedent of customer loyalty (Reicheld & Schefter, 2000; Garbarino & Johnson, 1999; Chaudhuri & Holbrook, 2001; Flavián et al. 2006). Usually in the studies scrutinizing the possible correlation between trust and loyalty, trust is seen more or less as a unitary construct (see e.g. Gummerus et al. 2004, Floh & Treiblmeier, 2006; Flavián and Guinalú, 2006). As notified in

several studies within IS, trust is not a monolith, but rather a wide and multidimensional construct. (Li et al. 2006, 132.)

Based on the prior literature it seems intuitive that some degree of trust is needed to obtain customer loyalty. However, the nature of this correlation has to date remained a less studied area. For instance, one can ask whether the correlation between trust and loyalty is linear, curvilinear, or perhaps something else. Is there a threshold level of trust, or, on the other hand, whether a ceiling, a maximum level of trust exists? This paper scrutinizes literature to find out, to what extent these questions can be answered and where further research would seem appropriate.

In this study, the customer means an individual consumer, not a corporate customer. With respect to loyalty, the term customer loyalty instead of consumer loyalty or service loyalty is used. Examples of the usage of the term customer loyalty in similar contexts can be found from the e-commerce body of research (cf. e.g. Otim & Grover, 2006; Luarn & Lin, 2003; Floh & Treiblmaier, 2006).

In this study, B2C e-services are viewed in a rather wide sense as services that are delivered by commercial organizations to consumers via the Internet. Hence, services that are delivered using other electronic channels than Internet are excluded from this study.

The aim of this paper is two-fold. Firstly, by conducting an extensive review of literature, it scrutinizes trust and loyalty in B2C e-services. Secondly, the paper attempts to somewhat inspire the discussion within the information systems and e-commerce disciplines towards post-adoption consumer behavior perspectives.

Research approach

“However, despite an emerging interest among IS researchers toward the B2C e-commerce phenomenon, there is only a limited fragmented understanding of online consumer behavior” (Pavlou and Fygenon, 2006, 116).

As also pointed out by Pavlou and Fygenon (2006, 133), consumer behavior has understandably largely ignored IT issues, since they have not been relevant in the traditional physical business environment. This paper is positioned to contribute to narrow the gap between IS/e-commerce and consumer behavior research that will be identified based on the two-phase literature review.

In the first found of the literature review, a systematic review of IS literature on trust in the Internet was conducted. Figure 1 illustrates the topics and the structure of the literature review.

The journals selected to be included to the first round of literature review represent the top ten of Association for Information Systems MIS Journal Rankings, which is an average of ranking points from several journal rankings. The journals selected are MIS quarterly, Information Systems Research, Communications of the ACM, Management Science, Journal of Management

Information Systems, Artificial Intelligence, Decision Sciences, Harvard Business Review, IEEE Transactions and AI Magazine.

In order to limit the volume of articles to be examined, papers published prior 1995 are excluded from the literature review. 1995 is selected as a divider since the degree of commercial exploitation of Internet was rather limited prior 1995 and hence the topic of the study has become relevant after that. The review was conducted in March 2007.

The second round of the review explored literature on two broad areas, e-commerce, including e-services, and marketing, particularly services and relationship marketing. For e-commerce part, the following journals were reviewed systematically: Journal of Electronic Commerce in Organizations, International Journal of Electronic Commerce, Journal of Electronic Commerce Research and E-Service Journal. Consumer behavior literature was reviewed selectively to gain understanding on research around customer loyalty and e-services. In addition to the systematic reviews, searches using keywords were conducted in both rounds to ensure that the relevant articles were included. The approach of these searches is illustrated on page 6.

Since the study focuses on the B2C context, articles discussing B2B trust in B2B relationships were excluded from the review. Several studies have reported that trust has an important role in B2B relationships. (cf. e.g. Dwyer et al., 1987; Halinen, 1994; Ganesan, 1994.) However, including the B2B trust discussion would have extended the scope of the review and this paper substantially. This issue is elaborated further in the discussion section.

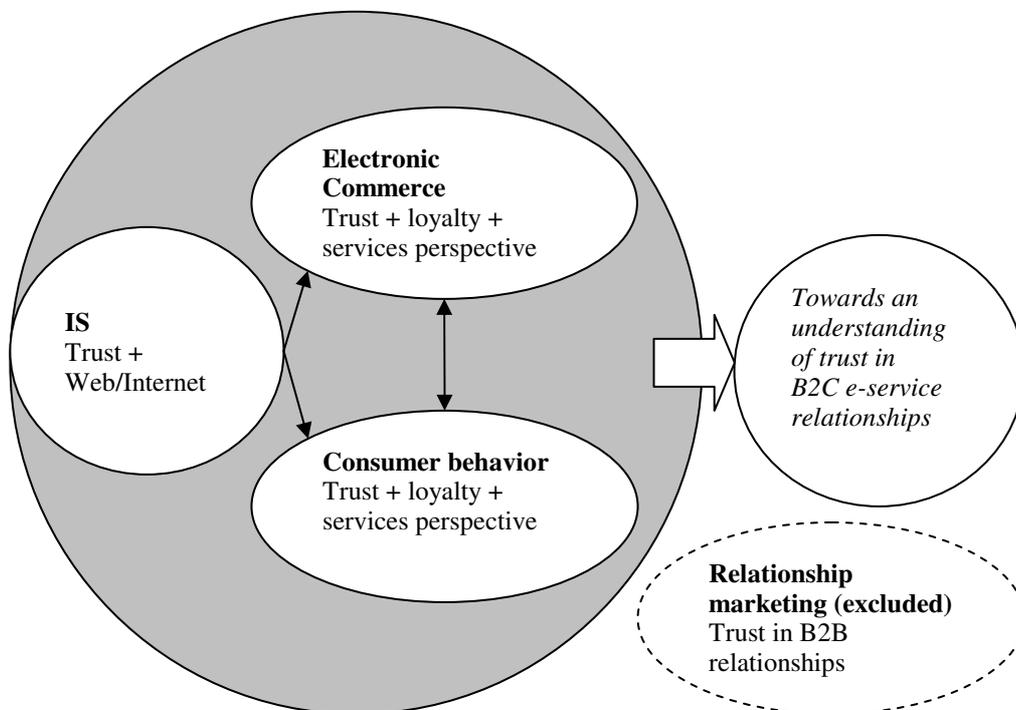


Figure 1. Structure of the literature review

Background – the concept of trust

Alongside marketing, IS and E-Commerce research streams, trust has been a topic of interest in several other disciplines e.g. psychology, sociology, organization theory, philosophy and economics. (see e.g. Järvenpää et al., 2004; Halliday, 2003.)

Because of its conceptual subjectivity and complexity, formulating a comprehensive definition of trust applicable for all disciplines is problematic. (Halliday, 2003, 409.) McKnight and Chervany state that three unabridged dictionaries give trust on average 17 definitions. Hence, trust as a term can be considered vague. (McKnight & Chervany, 2002, 36-37.) (See also Lee & Turban, 2001; (Grabner-Kräuter & Kaluscha, 2003.)

In social psychology, trust reduces the uncertainty associated with all social interactions. Generally speaking, human beings want to know in advance how their behavior will affect to others and vice versa. Perceived uncertainty can be reduced by laws, rules, agreements, social norms or regulations. To reduce this perceived uncertainty further, individuals, either consciously or subconsciously, decide to trust. (Gefen & Straub, 2004; Gefen et. al., 2003; Fukuyama, 1995.) In general terms, social psychology lays its interest on the reasons and factors that precede trusting attitudes and behavior, whereas sociology focuses on the institutional premises facilitating trust and psychology factors that influence person's disposition to trust. (Shapiro, 1987; Cowles, 1997.)

A common view in the literature is to see trust as something that grows over time, i.e. develops over time from lower to higher levels of trust. (See e.g. Rempel, Holmes & Zanna, 1985; Zand, 1972.) On the other hand, the findings of Kramer (1994) indicate that individuals with no interaction history can surprisingly have high level of trust. Hence, trust can be viewed as a dynamic and evolving phenomenon. (Grabner-Kräuter & Kaluscha, 2003.)

Even though a universal definition has not been accomplished, there is a consensus in the literature that riskiness is reduced by trust (Halliday, 2003, 408; McKnight et al., 2002, 335). Basic level of trust is required to be included in customer's evoked set for future purchases (Halliday, 2003, 410). Cowles views trusting behavior as a function of risk and reliance. (See Figure 2.) A 'trust threshold' distinguishes acts of trust from behavior that is not considered an act of trust. (Cowles, 1997, 273-282.)

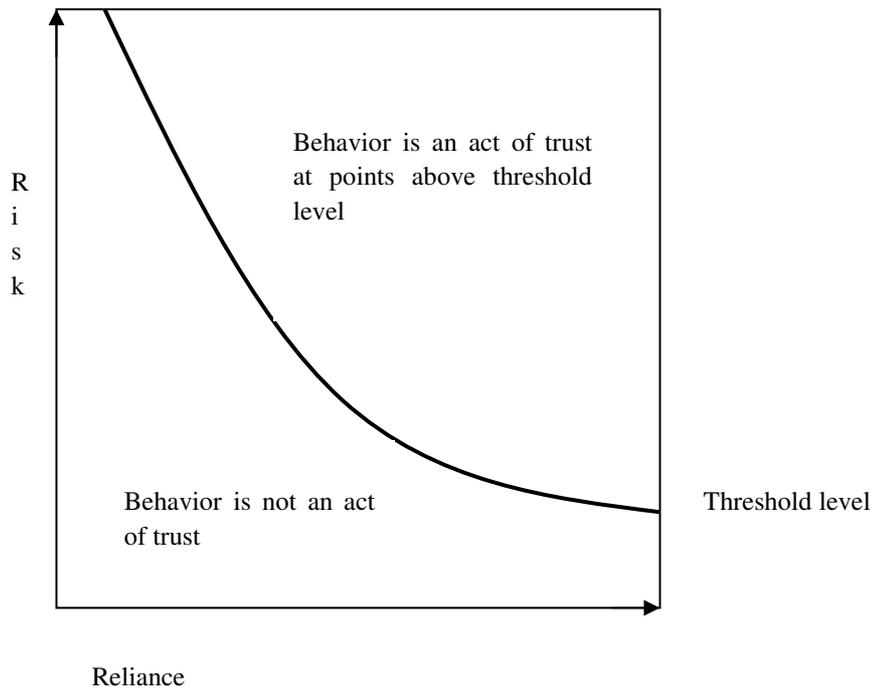


Figure 2. Trusting behavior as a function of reliance and risk (Cowles, 1997, 276)

Trust and the Internet

In the literature review conducted for this paper, EBSCOhost, ProQuest, Elsevier and Emerald databases were investigated. Search terms 'trust and internet' in the first phase and 'trust and internet and loyalty' in the second phase were used. Fields for these terms to exist were not specified to avoid restricting relevant content out of the selection. To reduce of risk of excluding literature because of search term, the search was also conducted by replacing 'internet' with 'world wide web' and 'web' as well as 'loyalty' with 'customer loyalty', 'consumer loyalty' and 'e-loyalty'. These searches produced considerably smaller numbers of hits. In addition, the results indicated that the search term 'internet' captured the literature in the interest of the study because the hits very to large extent the same.

Since Emerald is a database focusing more on marketing than IS literature whereas EBSCOhost includes content about other fields of business studies. As can be seen from the diagrams, the difference in numbers of hit between EBSCOhost and EMERALD is substantial, underlining the original interpretation that trust, internet and loyalty have not been widely discussed in IS literature so far. However, one could interpret that the interest in trust and loyalty in the Internet is growing steadily but surely. Based on the number of hits from EBSCO

(other) and Emerald one could interpret that the burst of the dot-com bubble had frozen the growth of interest for some time until the numbers started to grow 2002 onwards. Figure 3 illustrates the results.

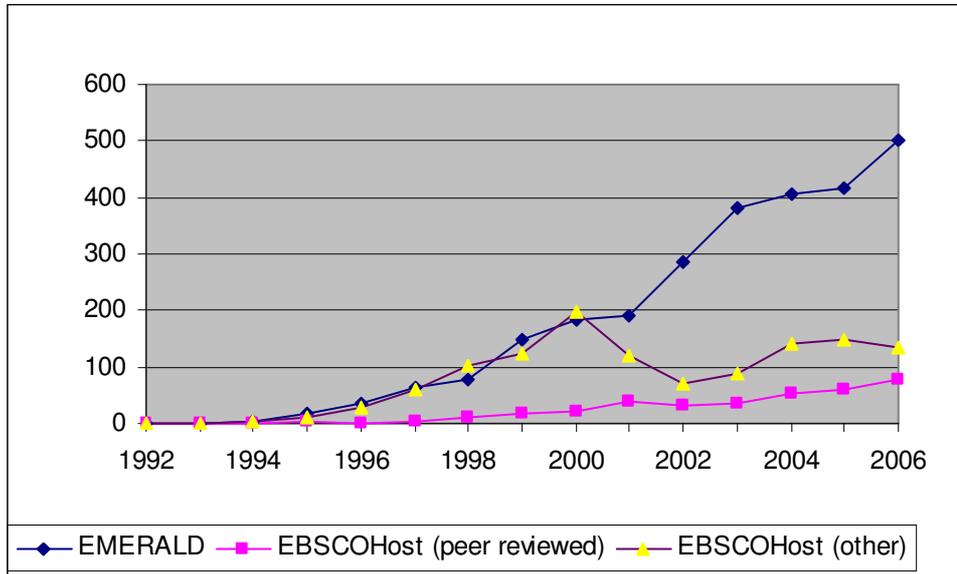


Figure 3. Hits for search term ‘trust AND internet’ per year

Figure 4 Presents a summary of part of IS and e-commerce literature around trust using a models by McKnight & Chervany (2002, 42 & 44) as a starting point that is complemented with findings of other studies.

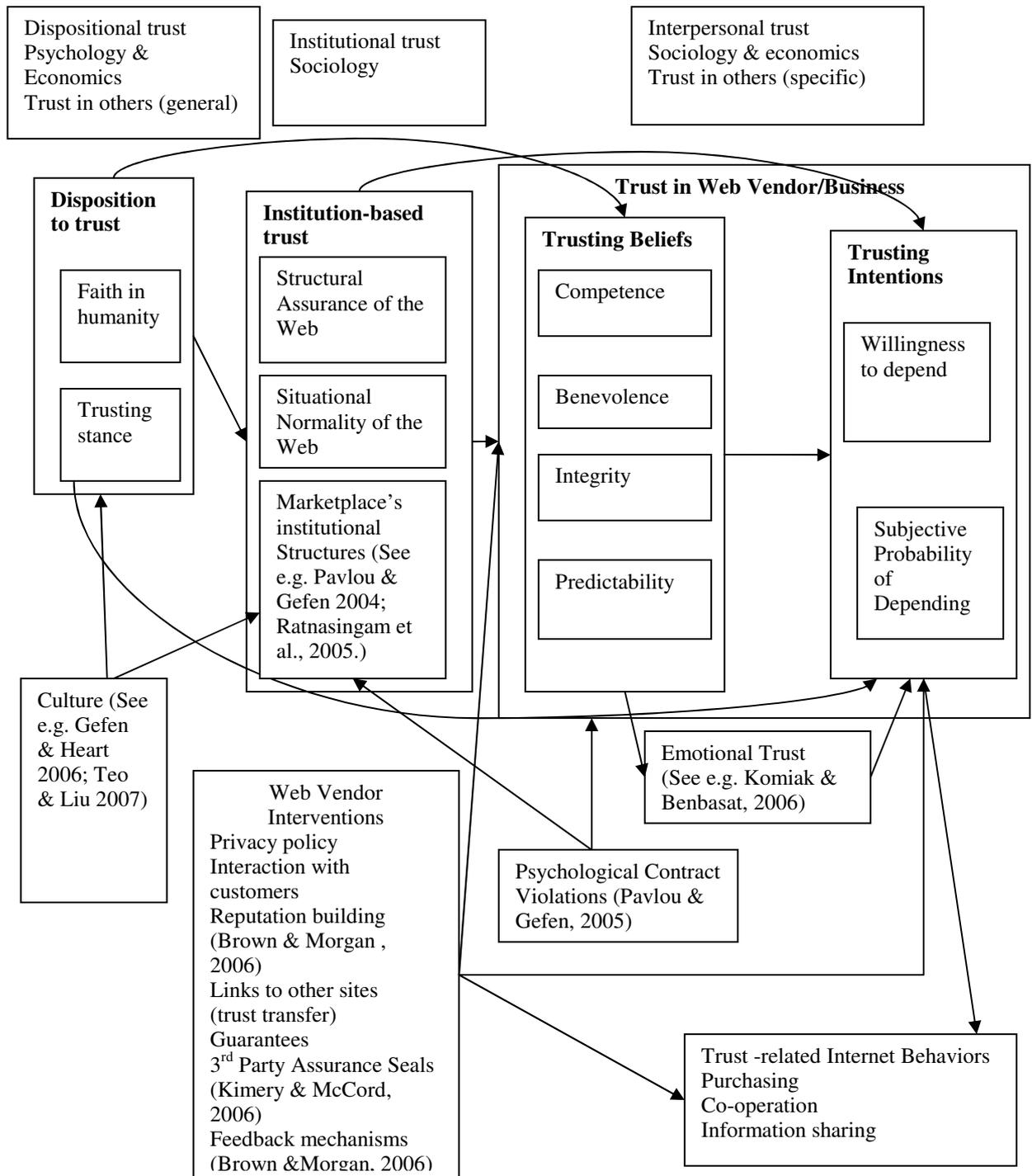


Figure 4. E-Commerce Customer Related Trust Constructs based on McKnight & Chervany, 2002.

With their Web Trust Model McKnight et al. strive to integrate different perceptions of trust within several disciplines. The theoretical foundation of the model lies in the theory of reasoned action (TRA) by Fishbein & Ajzen (1975) and the theory of planned behavior (TPB) (Ajzen, 1991). In brief, TRA posits that

beliefs lead to attitudes, which lead to behavioral intention, which leads to the actual behavior. TRA is a rather widely used theoretical framework on the IS field, e.g. technology acceptance model (TAM) is an application of TRA. Pavlou & Fygenson utilize in their study an extended version of TBP, perceived behavioral control (PBC). PBC is defined as a person's perception of easiness or difficulty to carry out a behavior. (Pavlou & Fygenson, 2006, 115-143; Gefen et al. 2003, 51-90.)

In the model, disposition to trust represents the psychological dimension of trust. Disposition to trust can be defined as a tendency to be willing to trust other people. The main components of disposition to trust are faith in humanity and trusting stance. Faith in humanity means that a person believes that other people are generally good, i.e. have good intentions. Trusting stance means that a person views it is generally beneficial to trust other people. In contrast, if a person would have a distrusting stance he or she would view not to trust as more beneficial.

Institution-based trust refers to sociological view of trust. It is the belief that the needed structural conditions (facilities, regulations, standards, legislation etc.) are in place to ensure that the outcome of the transaction is satisfactory. McKnight et al. suggest two dimensions of institution-based trust, situational normality and structural assurance. Situational normality means that the business transaction is conducted with no major deviations from what the customer has expected i.e. the service encounter meets the expectations. Structural assurance is created with guarantees, premises, laws and other 'safeguards' that reduce the customer's perceived risk. (McKnight et al., 2002, 335-341; Pavlou & Gefen, 2004, 37-41.)

Trusting beliefs mean that a person believes that an online vendor possesses the needed qualities to act in a manner that is beneficial for the trustor. McKnight et al. suggest trusting beliefs to consist of the components, competence, integrity and benevolence. Competence means that the customer believes that the vendor is capable of delivering what have been agreed. Benevolence means that a person believes that the vendor is motivated to act in one's interest and integrity that the vendor act honestly. (McKnight et al. 2002, 335-341.)

In their article, Gefen et al. investigate the role of trust and TAM in repeat purchasing in online environment. Their study showed a correlation between repurchase intentions and several aspects of trust. Additionally, according to Gefen et al. trust and some aspects of TAM, e.g. perceived ease-of-use are intertwined since a well-designed web page increases the ease-of-use but also has a positive impact on situational normality, which is an element of institution-based trust. Based on the empirical study, institution-based elements, structural assurances and situational normality have the strongest correlation with trust. (Gefen et al., 2003, 51-90.)

Komiak and Benbasat (2006, 941-960) contribute the discussion by including emotional aspects to the conceptualization of trust in context of IT adoption. As stated by Komiak and Benbasat (2006, 943), emotional trust has been excluded to

trust models to be able to focus on cognitive trust i.e. trusting beliefs (McKnight et al., 1998, 474.) and because emotional trust has been considered arguably irrelevant to a business transaction (Gefen et al., 2003, 60). Referring to Gefen et al. and McKnight et al. Komiak and Benbasat (2006, 953) state that IS studies have mainly conceptualized trust as trusting beliefs.

Excluding feelings from the trust model and emphasising the cognitive side represents a view called adopted from economics literature. Rational choice theory of economics means that economic actors make all their decisions with a comprehensive cost-benefit analysis based on perfect information of all factors relevant for the decision whereas Homo Economicus consistently seeks to maximize his well-being, a personal level utility-function. To what extent these assumptions of human nature hold true, is a questionable issue. Perhaps more than an illustration of reality per se, rational choice and Homo Economicus are tools for structuring aspects of economic behavior. However, in terms of theory development, including emotional trust to the trust model may provide a means of drawing a more comprehensive picture of the topic. As pointed out by Komiak and Benbasat (2006, 943) emotional trust can be either rational or irrational. Komiak and Benbasat define emotional trust as the extent to which one *feels* secure and comfortable about relying on the trustee, i.e. the attitude one possesses to the trusting behavior per se. Disposition to trust is person's perception of trusting in general and trusting belief to partner's integrity. It means that an individual believes that the partner will act honestly, whereas emotional trust refers to the degree of security and comfort an individual feels about conducting business with the partner in question.

In their study Komiak and Benbasat discover that emotional trust significantly increases the intention to adopt and that emotional trust mediates fully the impact of cognitive trust beliefs on the intention to adopt as a delegated agent, while it only mediates partially the impact of cognitive trust in integrity on the intention to adopt as a decision aid (Komiak & Benbasat, 2006, 956).

If it can be justified that individual's behavior is affected not only by "rational" cognitive factors, such as attitudes and beliefs, but also feelings and emotions, how to justify leaving either of these without consideration?

Trusting intentions consist of two components, willingness to depend and subjective probability of depending. Willingness to depend is a more general construct representing that a person is prepared to make oneself vulnerable to the trustee whereas the latter, subjective probability of depending, is a more concrete concept. It means that an individual is willing to trust another in specific ways. McKnight et al. suggest that subjective probability of depending would manifest itself in the Internet as willingness to follow advice, give personal information and place purchases.

The last step in the process, behavior, is the actual purchase or use of service. The focus of this paper lies particularly in the role of trust after the initial purchase i.e. in post-purchase behavior.

Gefen and Pavlou discuss the role of institution-based trust with online marketplaces and extend the area of trust research from dyadic one-to-one to relationships to a case of a several trustees, particularly trust in a community of sellers as group. (Gefen & Pavlou, 2004, 37-39.)

Gefen and Straub investigate the role of social presence in e-trust. In their study, Gefen and Straub find support for their hypothesis that social presence embedded in a website increases consumer's trust in an e-vendors integrity, predictability, ability and benevolence. (Gefen & Straub, 2004, 407-424.)

In recent research critical approaches towards trust issues has emerged. Psychological contract violations, in other words situations where a buyer possesses a perception of having being treated wrongly and their impact on buyer-seller relationships in online marketplaces are discussed. (Pavlou and Gefen 2005, 372-399). Another topical trend is a critical evaluation of trust-building mechanisms (Josang et al, 2007; Brown & Morgan, 2006). Issues related to feedback rating manipulations and lack of consumer attention and awareness of 3rd party assurance seals and privacy policy statements (Kimery & McCord, 2006; Meinert et al., 2007) may indicate that trust aspects will remain in the agenda. Increasing consumer awareness of the reliability issues of feedback ratings in electronic marketplaces may underscore the significance of appropriate and transparent trust-building measures in the future.

Third topical issue is related to cultural issues in trust in e-commerce. Traditionally, a vast majority of studies on trust in e-commerce have used populations of US students in the empirical research. Some recent studies have investigated the cultural differences concluding cultural differences as an issue that influences trust in e-commerce. (Gefen & Heart, 2006, Teo & Liu, 2007.)

Trust - distrust

Conceptually trust can be seen as a phenomenon that is not static in its nature but evolves and changes over time. Hence, the strength of trust is not the same for all persons, toward all companies in all settings etc but can be presented as a continuum. Scholars have discussed the extremes in the trust continuum. Few (Rotter, 1980, 1-7) have viewed trust and distrust as the two extremes of the same continuum whereas the majority disagrees with this interpretation and view trust and distrust as separate constructs. (cf. e.g. Cho, 2006.) Compared to trust, distrust has remained a less studied area. Its formation and possible different

relational outcomes compared to trust have not drawn extensive academic interest so far. (Cho, 2006, 25-26.)

Lewicki et al. (1998, 438-458) who regarded trust as separate because of following reasons a) they separate empirically b) they coexist c) they have different antecedents and consequences. To justify the empirical separation Lewicki et al. refer to Wrightsman¹, who viewed human nature scale separated into positively worded items (i.e. disposition to trust) and negatively worded items (i.e. disposition to distrust). When discussing the coexistence of trust and distrust Lewicki et al. utilized Mancini's² study of journalists and politicians, who both trust and distrust each other. Different antecedents and consequences were proofed by literature review of related studies on positive and negative affectives. Hence, Lewicki et al. viewed trust and distrust as opposite concepts. In their study, Benamati et al. (2006) empirically confirmed many of the findings of Lewicki et al. in the context of online banking.

Related trust and distrust in online purchasing, Järveläinen and Puhakainen (2004) extend the scope of discussion to customer's trust in his/her own web skills in the context of ferry cruise industry. In cases where legal and structural barriers related to purchasing can be seen overcome, only a small minority of customers is willing to purchase their ticket online. Järveläinen and Puhakainen seek to find explanations for this from the lack of experience and confidence customers may have. According to their study, inexperienced web users tend to prefer discussions with a travel agent to reserving their cruise using the company's web page to ensure that they will receive all the components and qualities they have expected. They also seem to believe that using the travel agent also provides them a better price than doing the reservation on their own. (Järveläinen & Puhakainen, 2004, 333-343.)

Trust and loyalty within B2C e-services

The second phase of literature review focused on exploring studies on customer loyalty and customer relationships in B2C e-commerce and the view of trust in these studies. The main areas for this discussion were e-commerce and marketing disciplines, particularly services marketing and consumer behavior literature. Table 1 illustrates this literature in a condensed format.

In the marketing literature, customer loyalty has been a central topic of interest. Related to loyalty also role of trust has been discussed. (see e.g. Ribbink et al., 2004; Anderson & Srinivasan, 2003; Gummerus et al., 2004.) In IS research

¹ Wrightsman, L. S. "Interpersonal Trust and Attitudes toward Human Nature" in Robison, J. P., Shaver, P. R., Wrightsman, L. S. (eds.) (1991), *Measures of Personality and Social Psychological Attitudes*. Academic Press; San Diego, CA, 373-412.

² Mancini, P. (1993) "Between Trust and Suspicion: How Political Journalists Solve the Dilemma", *European Journal of Communication*, vol. 8, no. 1, 33-51.

stream, loyalty has traditionally not been such a central issue but has recently started to draw growing attention. (See e.g Otim & Grover, 2006; Gefen et al., 2003, Cyr et al. 2007, Luarn & Lin, 2003.) Figure 5 illustrates the development of number of studies.

Literature discussing the role of trust in customer relationships in B2C e-services is scarce and has mostly taken place in marketing discipline. Studies focusing primarily on trust have been able to draw a somewhat rich picture of multi-faceted and evolving concept of trust. However, research investigating relationships between trust and other key relationship constructs such as satisfaction, service quality, perceived value, commitment and loyalty generally view trust as unitary construct.

Viewing trust as a monolith is linked to the research settings of the studies. Generally the empirical studies are conducted by quantitatively testing hypotheses about the correlation between the key constructs such as satisfaction, service quality, trust and loyalty. In addition, the results obtained from the studies depend on how different construct are positioned as variables in the research setting. This can lead to somewhat conflicting results about the role of trust. (see e.g. Gummerus et al., 2004; Cyr et al., 2007; Anderson & Srinivasan, 2003.

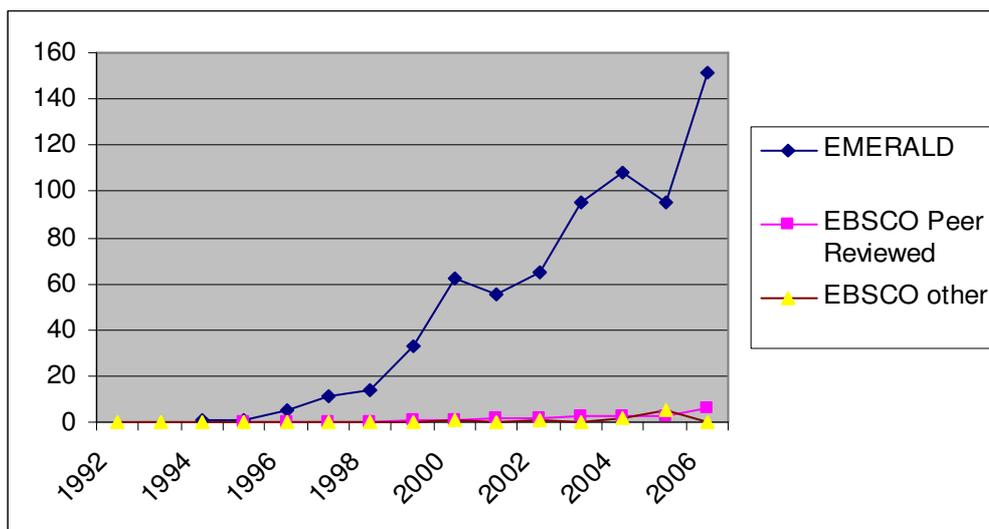


Figure 5. Hits for search term 'trust AND internet AND loyalty' per year

Article	Field of research	Area	Theoretical framework & Methods	View of trust	Key Ideas
Luarn & Lin (2003)	Electronic Commerce	E-Services	Quantitative Trust-commitment theory (Morgan & Hunt 1994) Proposed loyalty model	Set of specific beliefs (integrity, benevolence, competence and predictability) Monolith	Commitment as a powerful mediator between trust, satisfaction, perceived value and loyalty Correlation between trust and commitment weaker than satisfaction or perceived value Conceptualization of "traditional" customer loyalty in e-service context
Otim & Grover (2006)	E-commerce/IS	Web-based service delivery	TRA Quantitative	Trust not discussed Security/privacy issues less important than before because of availability of standardized security modes (safeguards). Online shoppers goal-oriented -> do not value social involvement	Dividing service delivery into pre-purchase, transaction-related and post-purchase services Post-purchase services, particularly customer support has the strongest impact on repurchase intentions Satisfaction with product ownership experience is instrumental in generating repeat purchases
Li et al. (2006a)	Electronic commerce	E-commerce / web site	Investment model for interpersonal relationships & commitment-trust theory Quantitative	Monolith, however the authors discuss that trust is not un-dimensional Trust and commitment the predictors for stickiness intention	Commitment a stronger predictor for stickiness than trust. The impact of trust also mediated by commitment
Flavián & Guinalfú (2006)	Marketing	E-commerce	Quantitative Proposes a model that relates trust,	Monolith	Direct correlation between trust and loyalty, not only intention to buy

			privacy and security with loyalty to a web site		but also preference, cost and frequency of visits. Perceived security as an important antecedent of trust
Harris & Goode (2004)	Marketing	E-commerce & E-service (Books.com & Flights.com)	Applying Oliver's (1997) sequential loyalty chain in an online context	Monolith	Trust as a central driver of loyalty, direct correlation notified Oliver's loyalty model reliable and valid in online context. nature of online exchange rather relational than transactional
Thatcher & George (2004)	Electronic Commerce	E-commerce	TRA Quantitative	Trust in the Internet monolith Trust in the Internet not correlated to loyalty, once consumers gain a sufficient level of experience to form a committed relationship to a vendor → threshold level?	Existing marketing models relevant for Web shopper behavior. Social involvement magnifies the relation between commitment and loyalty to a vendor.
Chiou & Shen (2006)	Marketing	Portals	Theory of emotion and adaptation Quantitative	Trust discussed in relation to opportunism, not as a variable	Opportunism has a surprisingly small impact on perceived satisfaction Satisfaction and investment in the relationship important for loyalty
Flavián et al. (2006)	Marketing/ E-Commerce	Website loyalty	Quantitative	Trust as set of beliefs monolith	The effect of website usability on loyalty seems to be conditioned by trust and satisfaction
Li et al. (2006b)	IS	E-commerce site	The investment model Organizational commitment	Monolith (focus on commitment)	Trust has a direct impact on behavioral intention (return to the site) and

			theory Commitment-trust theory Quantitative		indirect via affective commitment Trust between web site and customer increases likelihood for use intentions.
Pavlou et al. (2007)	IS	E-commerce (books & prescription drugs)	Principal-agent theory Quantitative Longitudinal	Monolith	Trust impacts purchase intentions indirectly through perceived uncertainty
McKnight & Chervany (2002)	E-Commerce	E-commerce	TRA Conceptual paper	Multidimensional	Focuses on different aspects of trust, not customer relationships, yet mentioned in the title.
Gummerus et al. (2004)	Marketing	Services marketing Online health-care service	SERVQUAL Satisfaction-loyalty link Quantitative	Monolith Trust as a mediator between service quality dimensions and customer satisfaction	Service quality-trust-satisfaction-loyalty chain Trust as an important mediator of customer loyalty
Liljander et al. (2006)	Marketing	Services marketing Self-service technologies in airline check-in	Technology readiness (TR) (customer's mental readiness to adopt technologies) Quantitative	Trust not explicitly discussed Insecurity referring to lack of trust in technology	Insecurity has a negative impact on TR
Cyr et al. (2007)	IS/E-commerce	E-services	TAM (applied) Quantitative	Monolith, yet the multidimensional nature of trust is discussed	Trust mediates between perceived social presence and e-loyalty
Anderson & Srinivasan (2003)	Marketing	E-commerce	Loyalty & Satisfaction Quantitative	Monolith	Trust mediates between E-satisfaction and e-loyalty
Ribbink et al. (2004)	Marketing	Services marketing	Loyalty literature Quantitative	Trust viewed only as trust to an e-tailer, yet other aspects i.e. dispositional, system-based and interpersonal are discussed.	E-trust has a moderate direct impact on e-loyalty, but weaker than e-satisfaction has. E-trust mediates between e-satisf. and e-loyalty

Selnes & Hansen (2001)	Marketing	Services marketing	Social network theory Quantitative	Not discussed	Transforming into self-service may lead to decreased customer loyalty since social-bonds are removed
Pitta et al. (2006)	Marketing	Marketing	Conceptual paper Marketing literature	Multi-dimensional	Trust needs to be nurtured throughout the whole customer relationship to keep customer loyal
Ha (2004)	Marketing	Marketing	Quantitative web survey Marketing literature	Brand trust Monolith	Brand trust an important factor for relationship length Community a keystone for brand trust Brand trust affects commitment
Gefen et al. (2003)	IS/E-Commerce	Online shopping	TAM Quantitative	Multi-dimensional	Trust in repeat purchasing
Floh & Treiblmaier (2006)	E-Commerce	Internet Banking	Quantitative Multigroup analysis	Monolith	Trust mediates the impact of service quality and web site quality on loyalty.
Eastlick et al. (2006)	E-commerce	Online shopping	Quantitative Commitment-trust theory	Monolith	Trust mediates between reputation and commitment and privacy concerns and commitment. Trust and commitment are key elements of services e-tailers relationship with consumers.
Liao et al. (2006)	E-Commerce	Continued use of an e-learning service (virtual university in Taiwan)	TBP Expectation-disconfirmation model	Trust not discussed	Satisfaction has the strongest impact on intent to continue using an e-service. Satisfaction is motivated by disconfirmation and perceived ease-of-use.

Table 1. Summary of key literature on trust and B2C relationships in the e-environment.

Gefen et al. refer to Reicheld and Schefter (2000) in stating the trust to the e-vendor is a vital key to retain online customers. The studies of trust have focused more on technology adoption perspectives i.e. placing purchases online from a vendor for the first time. (Pavlou & Fygenson, 2006, 115-143.) Gefen et al. discuss the role of trust after this purchase has taken place hence adding an angle to the IS research on trust. (Gefen et al., 2003, 51-90.)

Halliday sees trust as a response fragile and not always worth strengthening to increase commitment. Trust as a response is dependent on the actions of the organization providing the service and the customer's willingness, ability or preparedness to trust. It can also be asked how much one player in the market can impact on the placed trust, a pre-assumption or general understanding the customers have. This brings up the question how, and to what extent, trust can be managed.

Trust models by e.g. McKnight et al. 2002 and McKnight & Chervany, 2002 have focused on initial trust in the Internet i.e. trust when a customer places purchases from the company for the first time. Trust after that, after a customer relationship between a company and a consumer has been established represents a less studied area of research. (see e.g. Thatcher & George, 2004; Wang & Head, 2007.)

According to Srini and Srinivasan (2005, 123-134) trust is (among e.g. perceived value) a moderating factor between e-satisfaction and e-loyalty. However, the authors acknowledge the problematic nature of controlling the trust by the management.

Based on the findings of their study, Thatcher and George (2004, 259) interpret that trust in the Internet has not a significant moderating role in commitment's relation to consumer loyalty. Once a customer has gained a sufficient experience of the vendor to form a committed relationship, trust in the Internet is overdriven by customer's commitment to the vendor. (Thatcher and George, 2004, 259-260.)

Mols (2000, 17) sees trust as a possible means of maintaining competitive position in the Internet banking since trust may create a switching barrier. Once a customer has used to deliver highly confidential information with a bank they will unlikely change to another bank.

According to Ribbink et al. (2004, 453) e-trust is has an important, yet not imperative, moderating role between e-satisfaction and e-loyalty. E-trust is difficult to influence directly because it is built based on multiple service encounters with multiple service providers. When thinking this finding in relation to ideas suggested by Mols (2000) it can be stated that a sufficient level of trust is a prerequisite for purchasing the service via the Internet. As a result, companies striving to serve customers in virtual channels need to nurture trust. This leads to the situation where all competitors need to fulfill customers' expectations of trust

within a certain period if they want to gain a foothold in the market. When customers become aware of this, they start to consider conducting the service online as a viable alternative. In other words, the customers tend to formulate a perception of the overall reliability of the industry which can then be reflected to the concept of trust between a customer and a company.

However, the concept of trust could also be viewed from a somewhat wider perspective. More emphasis could perhaps be put into understanding processes within the individual customer evaluates the trustworthiness of a company. Johnson and Auh (1998) discuss the impact of trust environment on the satisfaction-loyalty relationship. In their article, Johnson and Auh (1998, 15) view the trust environment as customer's purchase and consumption environment which consists of organizational, political, social and technological aspects. In particular, the authors discuss the role of the firm environment, i.e. the relationship between the firm and its employees, market environment, i.e. competition in addition to political, economic, social and technological environment.

Also cultural differences may have an impact on customer's perceptions of trust and importance of trustworthiness. (see e.g. Hofstede, 1984.) Fukuyama (1995) suggest that buyers and sellers in "high trust" societies such as Germany and U.S. should be more willing to engage trust relationships than buyers and sellers in "low trust" societies such as Russia or China.

In a society where individuals have no trust in each other, conducting any business transaction requires extensive contractual arrangements to exclude the possibility of opportunistic behavior. Self-evidently, transaction costs in this setting would be higher than if some level of trust would exist. With this respect, Fukuyama refers to term 'social capital' as trust the individuals have in a society or certain parts of it. (Fukuyama, 1995, 25-29; Gefen & Heart, 2006.)

One might also perhaps propose that the trustworthiness of the supplier is more important in some industries than others e.g. banking & finance vs. information services or e-entertainment. Perceived importance of a service category may be one factor influencing on the required level of trustworthiness (See e.g. Floh and Treiblmaier, 2006.)

As can be seen from table 1, the role of trust in post-adoption phase behavior has been rather extensively discussed in the services marketing literature. Yet, there is not a single clearly dominant forum for the discussion. Overall, the literature is scarce; of the 22 listed key articles 13 discuss the role of trust in after the initial purchase. In this context, only two articles (Gefen et al., 2003 and McKnight & Chervany, 2002), view trust as multi-dimensional construct.

Discussion

Implications for research

Research on the role of trust in customer relationships in B2C electronic service is scarce and the area is somewhat fragmented into several disciplines such as consumer behavior, information systems and electronic commerce. In contrast, in the relationship marketing literature the role of trust in customer relationships has been extensively discussed in the B2B context (see e.g. Halinen, 1994; Doney & Cannon, 1997). The relationship marketing literature also contains somewhat established models to describe the role of trust such as the trust-commitment theory by Morgan & Hunt (1994) and the attraction-trust-commitment model by Halinen (1994).

When scrutinizing trust in relation to other constructs related to customer relationship, trust is generally seen as a monolithic concept, which leaves the widely acknowledged multi-faceted nature of trust ignored. If the role of trust is empirically investigated by asking: 'do you trust X?' the underlying reasons for trusting, not trusting or distrusting remain unrevealed. A positive answer represents only the tip of an iceberg.

Quantitative research methods dominate the field around trust and customer relationships, yet recent literature also includes a qualitative example (Pennanen et al. 2006). Because of varying definitions and operationalizations of trust, comparing different studies is somewhat problematic. Being able to clearly define the key concepts are postulate the problems substantially increases the usability of quantitative research methods. Hence, alternative methods for empirical research would be worth considering.

Research so far has applied multiple theoretical approaches. One clearly dominant theoretical model was not found. Using several background theories can provide a richer picture of the phenomenon. On the other hand, missing a clear theoretical foundation may reduce the pace of development in the field.

Research published so far has commonly viewed trust as one variable in formation of customer loyalty. In these studies trust has been positioned in several ways among the other related constructs e.g. service quality, satisfaction and commitment. Empirical support found for these findings either underline the multi-faceted, complex nature of trust or may lead us to ponder whether all the studies have actually grasped the true nature of trust, what ever that is.

Implications for practitioners

The characteristics of e-service environment support the building of institution-based trust. E-service environment is rather suitable for gaining a high-level situational normality in service encounters since the service delivery can be automated. On the other hand, a service provider has less influence on possible customer-dependent factors in a virtual environment. Companies providing their products and services have adopted a variety of techniques for creating institution-based trust. Structural assurances i.e. feedback mechanisms, privacy statements and 3rd party seals are widely used strategy to create institution-based trust online and also applicable to e-services. However, increasing consciousness of challenges related to assurances such as manipulating the feedback ratings in eBay and lack of attention and understanding of 3rd party seals and privacy policy statements reported in recent studies (see e.g. Brown & Morgan, 2007; Hassanein & Head, 2007; Kimery & McCord, 2006; Meinert et al., 2006) are issues to be considered. Keeping in mind the multi-faceted nature of trust, to what extent one actor in the market can influence trust and what is the level of trust needed to keep customers loyal can be interesting questions.

Further research

Widening the view of trust from monolithic to multidimensional direction would be important to better grasp the nature of trust. Examining the impacts different dimensions of trust such as, integrity, benevolence, predictability and competence as well as the role of institutional and structural mechanism and their impact of customer relationships could be a possible path for further analysis.

Though some recent studies shed light on cultural differences associated with trust (see e.g. Gefen & Heart, 2006) the empirical research is still dominated by studies conducted within student population in the US. Studies in other cultural settings with other demographic groups would possibly provide more understanding of current models.

So far, majority of the studies have provided only a static view of trust focusing on certain point of time. Since trust is a dynamic construct, new approaches, better capturing the dynamic nature of trust would perhaps be beneficial for understanding the phenomenon. (Winch & Joyce, 2006.)

Since the role of trust in B2B relationships has been studied extensively within the relationship marketing research stream, utilizing existing findings and testing their applicability in the B2C e-service context could be a potential avenue for further investigation (see e.g. Eastlick et al., 2006).

Quantitative research methods have so far dominated the research on trust in B2C e-service relationships. Applying alternative research methods, e.g. case study approach or ethnographic research would enhance understanding of trust in e-relationships.

Conclusions

The first aim of this paper was to conduct an extensive review of literature discussing trust and loyalty in B2C e-services. Based on the findings of investigated IS, e-commerce and consumer behavior studies, trust plays a central role in B2C e-service relationships. The exact nature of this role may vary case by case and evolve during the relationship. Investigating the role further requires empirical research.

Secondly, this study attempted to inspire the discussion within the information systems and e-commerce disciplines towards post-adoption consumer behavior perspectives. Prior research discussing the role of trust in B2C e-service relationships is scarce and fragmented. In the literature around the topic, trust largely seen as a monolithic construct, which does not completely correspond the view of trust that e.g. IS research has adopted. Neither increasing adoption of e-commerce and e-services nor emergence of various structural trust-building mechanisms has made trust issues insignificant from practical or academic perspective, particularly in the post-adoption context. This paper aims to act as a starting point towards a theoretical framework.

Acknowledgments

The author gratefully acknowledges the valuable advice from professor Jussi Puhakainen, Turku School of Economics to improve the paper and the financial support received from Jenny and Antti Wihurin rahasto, Foundation for Economic Education and Turun Kauppaopetussäätiö (Foundation of Commercial Education in Turku).

References

- Anderson, R. E. and Srinivasan, S. S. (2003) "E-satisfaction and e-loyalty: a contingency framework", *Psychology and Marketing*, vol. 20, no. 2, 123-138.
- Ba, S. and Pavlou, P. A (2002) "Evidence of the Effect of Trust Building Technology in Electronic Markets: Price Premiums and Buyer Behavior", *MIS Quarterly*, vol. 26, no. 3, 243-268.
- Balabanis, G., Reynolds, N., and Simintiras, A. (2006) "Bases of e-store loyalty: Perceived switching barriers and satisfaction", *Journal of Business Research*, vol. 59, no. 2, 214-224.
- Bejou, D., Ennew, C. T. and Palmer, A. (1998) "Trust, ethics and relationship satisfaction", *International Journal of Bank Marketing*, vol. 16, no. 4, 170-175.
- Benamati, J., Serva, M. A., and Fuller, M. A. (2006) "Are Trust and Distrust Distinct Constructs? An Empirical Study of the Effects of Trust and Distrust among Online Banking Users", *Proceedings of the 39th Hawaii International Conference of System Sciences (HICSS'06)* Track 6, 121b.
- Brown, J. and Morgan, J. (2006) "Reputation in Onlice Auctions: The Market For Trust", *California Management Review*, vol. 49, no. 1, 61-81.

- Chaudhuri, A. and Holbrook, M. B. (2001) "The chain effects from brand trust and brand affect to brand performance: the role of brand loyalty", *Journal of Marketing*, vol. 65, no. 2, 119-129.
- Chiou, J-S and Shen, C-C. (2006) "The effects of satisfaction, opportunity, and asset specificity on consumers' loyalty intentions toward internet portal sites", *International Journal of Service Industry Management*, vol. 17, no. 1, 7-22.
- Cho, J. (2006) "The mechanisms of trust and distrust formation and their relational outcomes", *Journal of Retailing*, vol. 82, no. 1, 25-35.
- Copeland, M. T. (1923) "Relation of consumers' buying habits to marketing methods", *Harvard Business Review*, vol. 1, no. 3, 282-289.
- Cowles, D. L. (1997) "The role of trust in customer relationships: asking the right questions", *Management Decision*, vol. 35, no. 4, 273-282.
- Curasi, C. F. and Kennedy, K. N. (2002) "From prisoners to apostles: a typology of repeat buyers and loyal customers in service businesses", *Journal of Services Marketing*, vol. 16, no. 4, 322-341.
- Cyr, D., Hassanein, K., Head, M., and Ivanov, A. (2007) "The role of social presence in establishing loyalty in e-Service environments", *Interacting with Computers*, vol. 19, no. 1, 43-56.
- Doney, P. M. and Cannon, J. P. (1997) "An Examination of the Nature of Trust in Buyer-Seller Relationships", *Journal of Marketing*, vol. 61, no. 2, 35-51.
- Dwyer, F, Schurr P., and Oh, S. (1987) "Developing Buyer-Seller Relationships" *Journal of Marketing*, vol. 51, no. 2, 11-27.
- Eastlick, M. A., Lotz, S. L., and Warrington, P. (2006) "Understanding online B-to-C relationships: An integrated model of privacy concerns, trust, and commitment", *Journal of Business Research*, vol. 59, no. 8, 877-886.
- Fishbein, M. and Ajzen, I. (1975) "*Belief, Attitude, Intention and Behavior*" Addison-Wesley, Reading, MA, USA.
- Flavián, C. and Guinalú, M. (2006) "Consumer trust, perceived security and privacy policy Three basic elements of loyalty to a web site", *Industrial Management & Data Systems*, vol. 106, no. 5, 601-620.
- Flavián, C., Guinalú, M., and Gurrea, R. (2006) "The role played by perceived usability, satisfaction and trust on website loyalty", *Information and Management*, vol. 4, no. 1, 1-14.
- Floh, A. and Treiblmaier, H. (2006) "What Keeps the E-Banking Customer Loyal? A Multigroup Analysis of the Moderating Role of Consumer Characteristics on E-Loyalty in the Financial Service Industry", *Journal of Electronic Commerce Research*, vol. 7, no. 2, 97-110.
- Fukuyama, F. (1995) *Trust: The Social Virtues and the Creation of Prosperity*. Penguin Books Ltd., London, UK
- Ganesan, S. (1994) "Determinants of Long-Term Orientation in Buyer-Seller Relationships", *Journal of Marketing*, vol. 58, no. 2, 1-19.
- Garbarino, E. and Johnson, M. S. (1999) "The Different Roles of Satisfaction, Trust and Commitment in Customer Relationships", *Journal of Marketing*, vol. 63, no. 2, 70-87.
- Gefen, D. and Straub, D. W. (2004) "Consumer trust in B2C e-Commerce and the importance of social presence: experiments in e-Products and e-Services", *Omega – The International Journal of Management Science*, vol. 32, no. 6, 407-424.
- Gefen, D., Karahanna, E., and Straub, D. W. (2003) "Trust and TAM, in Online Shopping, An Integrated Model", *MIS Quarterly*, vol. 27, no. 1, 51-90.
- Gefen, D. and Heart, T. (2006) "On the Need to Include National Culture as a Central Issue in E-Commerce Trust Beliefs", *Journal of Global Information Technology Management*, vol. 14, no. 4, 1-30.

- Grabner-Kräuter, S. and Kaluscha, E.A. (2003) "Empirical research in on-line trust: a review and critical assessment", *International Journal of Human-Computer Studies*, vol. 58, no. 6, 783-812.
- Grewal, D., Iyer, G.R., Krishnan, R., and Sharma, A. (2003) "The Internet and the price-value-loyalty chain", *Journal of Business Research*, vol. 56, no. 5- 391-398.
- Gummerus, J., Liljander, V. Pura, M., and van Riel, A. (2004) "Customer loyalty to content-based web sites: the case of an online health-care service", *Journal of Services Marketing*, vol. 18, no. 3, 175-186.
- Ha, H-Y. (2004) "Factors Affecting Online Relationships and Impacts", *The Marketing Review*, vol. 4, no. 2, 189-209.
- Halinen, A. (1994) "*Exchange Relationship in Professional Services. A Study of Relationship Development in the Advertising Sector*", Publications of Turku School of Economics and Business Administration, Series A-6:1994: Turku, Finland.
- Halliday, S. V. (2003) "Which trust and when? Conceptualizing trust in business relationships based on context and contingency", *International Review of Retail, Distribution and Consumer Research*, vol. 13, no. 4, 405-421.
- Harris, L. C. and Goode, M. H. (2004) "The four levels of loyalty and the pivotal role of trust: a study of online service dynamics", *Journal of Retailing*, vol 15, no. 6, 139-158.
- Hassanein, K. and Head, M. (2007) "Manipulating perceived social presence through the web interface and its impact on attitude towards online shopping", *International Journal of Human-Computer Studies*, article in press.
- Hoffman, D. L., Novak, T. P., and Peralta, M. (1999) "Building Consumer Trust Online", *Communications of the ACM*, vol. 42, no. 4, 80-85.
- Hofstede, G. (1984) "Culture's consequences", Sage Publications, Newbury Park, CA, USA,.
- Jacoby, J. and Chestnut, R. W. (1978) "*Brand Loyalty Measurement and Management*", John Wiley & Sons: New York.
- Johnson, D. and Grayson, K. (2005) "Cognitive and affective trust in service relationships", *Journal of Business Research*, 2005, no. 58, 500-507.
- Johnson, M. D. and Auh, S. (1998) "Customer Satisfaction, Loyalty, and the Trust Environment", *Advances in Consumer Research*, vol. 25, 15-20.
- Josang, A., Ismail, R., and Boyd, C. (2007) "A survey of trust and reputation systems for online service provision", *Decision Support Systems*, vol. 43, no.2, 618-644.
- Järveläinen, J. and Puhakainen, J. (2004) "Distrust of One's Own Web Skills: A Reason for Offline Booking after Online Information Search", *Electronic Markets*, vol. 14, no. 4, 333-343.
- Järvenpää, S. L., Shaw, T. R., and Staples S. D. (2004) "Toward Contextualized Theories of Trust: The Role of Trust in Global Virtual Teams", *Information Systems Research*, vol. 15, no. 3, 250-267.
- Kimery, K. M. and McCord, M. (2006) "Signals of Trustworthiness in E-Commerce: Consumer Understanding of Third-Party Assurance Seals", *Journal of Electronic Commerce in Organizations*, vol. 4, no. 4, 52-74.
- Komiak, S. Y. X. and Benbasat, I. (2006) "The Effects of Personalization and Familiarity on Trust and Adoption of Recommendation Agents", *MIS Quarterly*, vol. 30, no. 4, 941-960.
- Kumar, V. and Shah, D. (2004) "Building and sustaining profitable customer loyalty for the 21st century", *Journal of Retailing*, vol. 80, no. 4, 317-330.
- Lee, M. O. K and Turban, E. (2001) "A Trust Model for Consumer Internet Shopping", *International Journal of Electronic Commerce*, vol. 6, no.1, 75-91.

- Lewicki, R. J., McAllister, D. J. and Bies R. J. (1998) "Trust and Distrust: New Relationships and Realities", *Academy of Management Review*, vol. 23, no. 3, 438-458.
- Li, D., Browne, G. J., and Chau P. Y. K (2006) "An Empirical Investigation of Web Site Use Using a Commitment-Based Model", *Decision Sciences*, vol. 37, no. 3, 427-443.
- Li, D., Browne, G. J., and Wetherbe, J. C (2006) "Why Do Internet Users Stick with a Specific Web Site? A Relationship Perspective", *International Journal of Electronic Commerce*, vol. 10, no. 4, 105-141.
- Li, D., Bwowne, G. J., and Wetherbe, J. C. (2007) "Online Consumers' Switching Behavior: A Buyer-Seller Relationship Perspective", *Journal of Electronic Commerce in Organizations*, vol. 5, no. 1, 30-42.
- Liao, C., Chen, J-L., and Yen, D. C. (2006) "Theory of planning behavior and customer satisfaction in the continued use of e-service: An integrated model", *Computers in Human Behavior*, In Press, Corrected Proof. Available online 30 June 2006.
- Liljander, V., Gillberg, F., Gummerus, J., and van Riel, A. (2006) "Technology readiness and the evaluation and adoption of self-service technologies", *Journal of Retailing and Consumer Services*, vol. 13, no. 3, 177-191.
- Luarn, P. and Lin H-H. (2003) "A Customer Loyalty Model for E-Service Context", *Journal of Electronic Commerce Research*, vol. 4, no. 4, 156-167.
- McKnight, D. Harrison, Cummings, Larry L., and Chervany, Norman L. (1998) "Initial Trust Formation in New Organizational Relationships", *Academy of Management Review*, vol. 23, no. 3, 473-490.
- McKnight, D. H. and Chervany, N. L. (2002) "What Trust Mean in E-Commerce Customer Relationships: An Interdisciplinary Conceptual Typology", *International Journal of Electronic Commerce*, vol. 6, no. 2, 35-59.
- McKnight, D. H., Choudhury, V., and Kacmar, C. (2002) "Developing and Validating Trust Measures for e-Commerce: An Integrative Typology" *Informations Systems Research*, vol. 13, no. 3, 334-359.
- Meinert, D. B., Peterson, D. K., Criswell, J. R., and Crossland, M. D. (2006) "Privacy Policy Statements and Consumer Willingness to Provide Personal Information", *Journal of Electronic Commerce in Organizations*, vol. 4, no.1, 1-17.
- Mittal, B. and Lassar, W. M. (1998) "Why do customers switch? The dynamics of satisfaction versus loyalty", *Journal of Services Marketing*, vol. 12, no. 3, 177-194.
- Mols, N. P. (2000), "The Internet and Services Marketing - The case of Danish retail banking", *Journal of Internet Research*, Vol. 10, No. 1, 7-18.
- Morgan, R. M. and Hunt, S. D. (1994) "The Commitment-Trust Theory of Relationship Marketing", *Journal of Marketing*, vol. 58, no. 3, 20-38.
- Oliver, Richard L. (1997) "*Satisfaction: a behavioral perspective on the consumer*", McGraw-Hill, New York, NY, USA.
- Oliver, Richard L. (1999) "Whence Consumer Loyalty?", *Journal of Marketing Oct99 Special Issue*, vol. 63, no. 4, 33-44.
- Otim, S. and Grover, V. (2006) "An empirical study on Web-based services and customer loyalty", *European Journal of Information Systems*, vol. 15, no.6, 527-541.
- Pavlou, P. A. and Gefen, D. (2004) "Building Effective Online Marketplaces with Insitution-Based Trust", *Information Systems Research*, vol. 15, no. 1, 37-59.
- Pavlou, P. A. and Gefen, D. (2005) "Psychological Contract Violations in Online Marketplaces: Antecedents, Consequences, and Moderating Role", *Information Systems Research*, vol. 16, no. 4, 372-399.

- Pavlou, P. A. and Fygenson, M. (2006) "Understanding and Predicting Electronic Commerce Adoption: An Extension of the Theory of Planned Behavior", *MIS Quarterly*, vol. 30, no. 1, 115-143.
- Pavlou, P. A., Liang, H., and Xue, Y. (2007) "Understanding and Mitigating Uncertainty in Online Exchange Relationships: A Principal-Agent Perspective", *MIS Quarterly*, vol. 31, no. 1, 105-136.
- Pennanen, K., Tiainen T., and Luomala H. (2007) "A Qualitative Exploration of a Consumer's Value-Based e-Trust Building Process: A Framework Development", *Qualitative Market Research*, vol. 10, no. 1, 28-47.
- Pitta, D., Franzak, F., and Fowler, D. (2006) "A strategic approach to building online customer loyalty: integrating customer profitability tiers", *Journal of Consumer Marketing*, vol 23, no. 7, 421-429.
- Ratnasigam, P., Gefen, D., and Pavlou, P. A. (2005) "The Role of Facilitating Conditions and Institutional Trust in Electronic Marketplaces", *Journal of Electronic Commerce in Organizations*, vol. 3, no. 3., 69-82.
- Reicheld, F. F., Mackey, R. G. Jr., and Hopton, C. (2000) "E-customer loyalty – applying the traditional rules of business for online success", *European Business Journal*, Vol. 12, No 22, 173-179.
- Reicheld, F. F. and Schefter, P. (2000) "E-loyalty – Your Secret Weapon on the Web", *Harvard Business Review*, vol. 78, no. 7-8, 105-113.
- Rempel, J. K., Holmes, J. G. and Zanna, M. P. (1985) "Trust in Close Relationships", *Journal of Personality and Social Psychology*, vol. 49, no. 1, 95-112
- Ribbink, D., van Riel, A. C.R., Liljander, V., and Streukens, S. (2004) "Comfort your online customer: quality trust and loyalty on the internet", *Managing Service Quality*, vol. 14, no. 6, 446-456.
- Rotter, J. B. (1980) "Interpersonal Trust, Trustworthiness and Gullibility", *American Psychologist*, vol. 35, no. 1, 1-7.
- Salam, A. F., Iyer, L., Palvia, P., and Singh, R. (2005) "Trust in E-Commerce", *Communications of the ACM*, vol 48. no. 2, 73-77.
- Selnes, F. and Hansen, H. (2001) "The Potential Hazard of Self-Service in Developing Customer Loyalty", *Journal of Service Research*, vol. 4, no. 2, 79-90.
- Semeijn, J., van Riel, A. C. R., van Birgelen, M. J. H., and Streukens, S. (2005) "E-services and offline fulfilment: how e-loyalty is created", *Managing Service Quality*, Vol. 15, No. 2, 182-194.
- Shankar, V, Smith, A. K., and Rangaswamy, A. (2003) "Customer satisfaction and loyalty in online and offline environments", *International Journal of Research in Marketing*, vol. 20, no. 2, 153-175.
- Shapiro, S. P. (1987) "The Social Control of Impersonal Trust", *American Journal of Sociology*, vol. 93, no. 3, 623-658.
- Sirdeshmukh, D. Singh, J., and Sabol, B. (2002) "Consumer Trust, Value and Loyalty in Relational Exchanges", *Journal of Marketing*, vol. 66, no. 1, 15-37.
- Teo, T. S. H. and Liu, J. (2007) "Consumer trust in e-commerce in the United States, Singapore and China", *Omega - The International Journal of Management Science*, vol. 35, no. 1, 22-38.
- Thatcher, J. B. and George J. F. (2004) "Commitment, Trust and Social Involvement: An Exploratory Study of Antecedents to Web Shopper Loyalty", *Journal of Organizational Computing and Electronic Commerce*, vol. 14, no. 4, 243-268.

- Verona, G. and Prandelli, E. (2002) "A Dynamic Model of Customer Loyalty to Sustain Competitive Advantage on the Web", *European Management Journal*, vol. 20, no. 3, 299-309.
- Wang, F. and Head, M. (2007) "How can the Web help build customer relationships? An empirical study on e-tailing", *Information & Management*, vol. 44, no. 2, 115-129.
- Winch, G. and Joyce, P. (2006) "Exploring the dynamics of building, and losing, consumer trust in B2C eBusiness", *International Journal of Retail and Distribution Management*, vol. 34, no. 7, 541-555.
- Zand , D. E. (1972) "Trust and Managerial Problem Solving", *Administrative Science Quarterly*, vol. 17, no. 2, 229-239.

Conceptual models for data quality research

R de la Harpe
Cape Peninsula University of Technology
Cape Town
South Africa
delaharper@cput.ac.za

Abstract. This paper focuses on data quality, namely what it means, the different views and the different stakeholders. The question can be asked why, if data quality is regarded as important by organisations, is it still a problem in spite of many efforts to address the problems associated with data of lesser quality? This paradox needs to be investigated in order to understand why it exists and what its impact is on the success of an organization. The research output should indicate whether it is possible to generalize the understanding of data quality within a specific organization. It could lead to the development of a single theoretical framework of data quality issues to benefit other organizations. Data quality in terms of what it means and how it is implemented in organizations is complex and unpredictable enough to warrant further inspection. The situation is much more complex than might appear at first sight because of the following: different views, multiple stakeholders, many disparate data sources, lack of resources, high dependency on ICT with interchanges between numerous, diverse, distributed, large complex computer and communications networks and multi-user, multi-organizational environments. The research questions for this study are: Why is data quality still a concern in most organizations and could an appropriate framework be formulated to improve the management of data quality? The following empirical issues are also investigated: what are the complexities of data quality and how is it institutionalized within the context of a particular organization and how do the different data stakeholders perceive data quality and its importance in terms of their organizational needs? The purpose of this paper is to identify the possible issues of data quality and present them as a research framework that sufficiently provides for the complexities associated with data quality. This is an interpretive study based on two cases, one a business and the other a healthcare case and the interview questions were derived from the research framework and used during the interviews with the different data stakeholders. This paper does not

report on the empirical data but instead discusses how conceptual models were developed from the literature and theories. The resulting data quality research framework is not intended to be implemented in practice but instead provides the framework to order the empirical data in such a way as to obtain rich insights in the complexity of data quality. Once the data is analysed it still needs to be interpreted and only once an improved understanding is reached would it be possible to develop a simplified framework that can be adopted in practice. The paper concludes with the proposed data quality research framework as an alternative view of data quality where its social aspect is emphasized. This will make it possible to consider and investigate the different data quality perspectives and specifically how data stakeholders deal with these. The main focus of the research framework is how data stakeholders interact with the data objects in their everyday use of these objects. The actual research results based on the empirical study will be presented in further papers.

Keywords. Data quality, Data stakeholders, Data objects.

Introduction

Although the researcher's understanding of data quality was initially rather static, focusing on attributes and their quality dimensions, a better understanding evolved through the research process. Conceptual models were developed to deal with all the complexities that evolved during the literature review and these are presented in this paper. The paper concludes with a data quality research framework that combines the different conceptual models as an attempt to provide a framework for data quality research. All the conceptual models and diagrams presented in this study are the result of an iterative process where the models were refined through a continuous improved understanding of the particular aspects of the models. The first versions were mostly based on concepts identified in the literature and later on the fieldwork data contributed to validating and fine tuning of the models.

The paper is organized to present the different components of the proposed research framework. The first section deals with data, information and knowledge and the related meanings of quality means for these. Data stakeholders are the persons who would be using the data and whose view of its quality will influence the way they apply it. Data objects with their attributes are discussed next followed by how data stakeholders interact with data objects. The paper is concluded by the section with the proposed research framework.

Data quality

This section presents an overview of the current status of data quality research. Some references are also made to data quality issues identified by industry to

present the current status from a practitioner's viewpoint. The literature study first introduces data quality with a discussion on how data, information and knowledge are viewed in terms of this particular study. The section is concluded with a summary of the data quality issues that are considered in this study.

Introducing the concepts quality and data quality

Both the concepts quality and data have different interpretations and need to be clarified in terms of what they mean for this study. The complexity of data quality from an Industry viewpoint, as discussed in one of The Data Warehousing Institute (TDWI) reports, can be viewed in terms of three focal points, namely data quality; business quality processes; and data management techniques (Russom, 2006). The Industry definition of data quality is lengthy in an attempt to address its complexities that encompass both business and technological aspects.

Lillrank (2003) considers standard definitions of quality and elaborates these to apply them to data. He refers to closed system technical quality and open system negotiated quality and postulates these as ideal types as a basis for his definition of information quality. Quality approaches can be divided into different categories: a transcendent view associated with excellence where products or services include elements that are superior; value-based where value is associated with money where there is a relation between price and quality, e.g., performance at an acceptable price or conformance at an acceptable cost; manufacturing-based referring to conformity to requirements; user-based where the quality is determined by the users with the goal of meeting or exceeding customer requirements, referring to the level of customer satisfaction; product-based where quality is precise and measurable (Helfert and Herrmann, 2002; Lillrank, 2003). The problem with the view of excellence is its subjective nature and that value is not a property of a product or service, but of a transaction involving give and take. In this case quality does not equal value, but is rather an element that affects perceived utility in a transactional context. Different users will also have different quality requirements.

Since quality can be regarded as a subjective construction by the user rather than a thing, is it then possible to determine the nature of a relation? When quality is regarded as a relation then an agency perspective is necessary and the question could be: which of the relevant actors are to pass judgment about quality? The time aspect of quality is important where it may not be clear whether the user knows quality before, during or after production or emergence. Satisfaction in terms of quality could also have a downside leading to dissatisfaction. Based on the above Lillrank (2003) defines information quality as

“a bi-polar construct, where the one end is technical quality applied to artefacts, the other being interactive quality of deliverables produced as results of negotiations between products and customers”.

The above discussion on quality highlighted the different views on what quality actually means concluding that it has different meanings for different persons based on the purpose for which it is required. Quality should rather be regarded a desirable characteristic with a subjective nature depending on different quality requirements. The concept quality is therefore complex with many different views and interpretations. It may therefore be necessary to determine the view of data versus information versus knowledge adopted by this study before data quality is considered and defined.

Data, information and knowledge

Although many authors use the terms data and information interchangeably, it is necessary to establish the difference between data, information and knowledge to be able to investigate how these concepts are perceived and used.

Data is defined as a collection of symbols that signify real world system states and are brought together because they are considered relevant to some purposeful activity (Shanks and Corbitt 1999). For the purpose of this study only data and information and “*how*” people use data/information as embedded knowledge are considered. In fact while referring to information, it should be noted that what is information to one could be data to another.

Data represents “*raw*” facts and information is the internalisation of data into information by humans using their knowledge. The definition of information is illustrated in Figure 1. Information is the result of internalisation by a person attaching meaning to it, but, when exchanged with another person, is received as data by the other person.

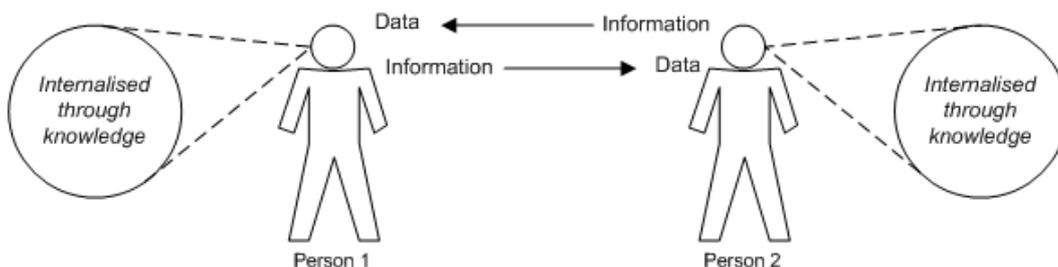


Figure 1. Illustration of data and information in terms of their human processing

Interpretation of data is also highly contextual, for example, an acronym can be interpreted differently depending on its context. Even though information is not regarded as a product, it may be useful to consider the analogy used by Neus (2003) that information is a service that can be regarded as a perishable product. He argues that people do not need information but decisions because “*the practitioner in need of the information has a definitive, often very small window of time and attention during which information can help to improve a decision*”.

The perishable nature of information may be significant since something that may be useful today, may be useless tomorrow. If information is considered as a product, as proposed by Wang and Strong (1996), most of the technical issues may be addressed without the social issues being addressed sufficiently.

Data is the representation of the real world and any given real-world entity, process, or phenomenon can be modelled by many different data views, depending on one's purpose (Rothenberg 1996). Data, as an abstraction of a real-world object, can be presented with different levels of detail. Each organisation usually has its own information system depicting its view of the real world applicable to it. The environment of the organisation will determine this view as well as its context based on how they use their data in their business processes.

Knowledge involves the mental processes of comprehension, understanding and learning of an individual and remains “*within*” the individual regardless of how much that individual interacts with the outside world or other individuals (Wilson, 2002). What a person knows is expressed as “messages” that do not carry knowledge but constitute information to be received as data by others.

The modes and domains of knowledge about data production processes were considered by Lee and Strong (2003) in a study where they examined the relationship between process knowledge and data quality outcomes. They distinguish between three modes of knowledge, namely, knowing-what, knowing-how and knowing-why. Knowing-what refers to the understanding of the activities involved in the process. Knowing-how refers to the understanding of the procedures to handle known data quality problems. Knowing-why refers to the ability to analyse underlying principles and to discover previously unknown data quality problems and solutions. They found that all three knowledge modes are significant for producing data of high quality.

Chung *et al.* (2002) suggested a conceptual framework based on General Systems Theory as an appropriate model to facilitate academic discourse among different disciplines to reach a shared understanding of how diverse data quality skills should be classified and contrasted. They refer to three categories of data quality skills as technical, adaptive and interpretive capabilities based on the levels of General Systems Theory, namely the mechanical, open and human systems. Their research aim was to establish a shared understanding by data quality researchers and practitioners and their preliminary results indicated that both adaptive and interpretive capabilities were perceived as most important.

The ability and knowledge of data stakeholders to interact with diverse constituents of data quality are important. Data stakeholders have the ability to adapt how they interact with the data object based on how they reflect on their actions and how they use their explicating knowledge. The more experienced they are the better they can adapt and improvise as they are influenced by the environment in which they operate.

Humans do not only react to their environment but interpret their situations and attach symbolic social meaning to their actions. Interpretive capabilities therefore refer to the ability of identifying and describing the complex interplay between technologies and organisational structure (Chung *et al.* 2002). Users therefore use data and attach a quality perception to it as they internalize it during their organisational activities. It is therefore necessary to consider data and its quality and what that means to the users as they internalise it.

Data and quality

The previous sections discussed the difficulty in defining quality and the differences between data, information and knowledge considering it from a human perspective, specifically with regards to the human's role in both. This section links the previous two sections to present the data quality view that will be followed in this study.

One view of data of high quality is if it satisfies the requirements stated in a particular specification and the specification reflects the implied needs of the user. This is in terms of conformance to its intended use, where the utility and users are the qualifying indicators for data quality (Abate *et al.* 1998; Vassilididis *et al.* 1999; Atkins 2001; Loshin and Inbar 2002). Data quality is most commonly defined as data that is “*fit for use*”; “*meet or exceed customer expectations*”; “*meets specifications or requirements*”; and “*be of high value to its users*” was the findings by Eppler and Wittig (2000) based on the seven frameworks they evaluated. The concept of quality is relative depending on the different perceptions and needs of the different data stakeholders. Redman (2003) emphasizes the pre-eminence of the “*customer*” and argues that the different needs of customers also change over time. Understanding changing customer needs can therefore be time-consuming and difficult.

Much of the existing work on data quality describes a list of desirable data quality dimensions (Wand and Wang 1996) and sees data quality as an organisational asset that has to be managed. The problem then becomes a management problem and the ‘solution’ an attainable feat in terms of standard management approaches. That data quality is not so simple is borne out nicely by the framework of Shanks and Darke (1998), quoted in Lederman *et al.* (2003). Their framework distinguishes syntactic, semantic, pragmatic and social data quality. Syntactic data quality is concerned with the structure of data and attempts to achieve consistency of representation. Semantic data quality is concerned with the meaning of data as assigned by the users of the data and attempts to ensure that data is complete, accurate and up-to-date. Pragmatic data quality is concerned with the use of data and attempts to ensure usefulness and usability. Social data quality is concerned with the shared understanding of data by various social groups within organisations (Shanks and Corbitt 1999) and is relevant for organisations that have multiple points of contact with customers. This study

regards the social data quality level as an important consideration in order to provide for the complexities of data quality experienced by humans.

A standard management approach (even if this is based on a Total Quality Management approach) to data quality may at most address some of the technical issues involved – in terms of the above framework, some of the syntactic, semantic and pragmatic data quality issues. The non-technical issues, i.e., the social issues, will escape attention and, most probably, thwart all attempts of bringing order in the data quality household.

Data stakeholders as the persons who would be involved with data are discussed next.

Data stakeholder

Data stakeholders are persons using data who have an interest in how it is defined and how they can use it. Examples of data stakeholders are management using data for decision-making; a salesperson; a doctor, etc. Although stakeholders are usually humans, it is possible that a stakeholder is another organisation, a department, a hospital, etc. and this aspect is further unpacked in terms of the data stakeholder relation to data usage in further sections. The term data stakeholder is used as a generic term to describe any party interested in data regardless of the context. An external party is an outside person or organisation that shares organisational data with an organisation.

It is important to identify these stakeholders to ensure that their relationships with each other and their roles within the network can be studied. According to Pouloudi *et al.* (2004) little guidance is available on how to identify the stakeholders of a network. They suggest stakeholder analysis as an approach to follow data stakeholders as actors for the researcher engaging in complex socio-technical phenomena. They adapted Freeman's (1984) definition of organisational stakeholders of an information system as "*any individual, group, organisation or institution who can affect or be affected by the information system under study*".

Stakeholders are goal-oriented, operate at different levels of organisations and are characterised by their performing and controlling activities (Swan *et al.*, 2000). They further state that stakeholders usually do not operate in isolation but form relationships with others and their degree of control of resources depends on their direct or indirect ownership within the network hierarchy. It is also important to consider the power, legitimacy and urgency of actors and how that may impact the relationships formed in the network. Power refers to the extent that one actor can influence the behaviour of other actors and if it is legitimate power, whether it is acceptable within socially constructed norms (Pouloudi *et al.*, 2004). Urgency refers to how soon actions need to be attended to and is often time sensitive.

Managers often have to deal with multiple, often conflicting interests and expectations (Pouloudi, *et al.*, 2004). Linde *et al.* (2003) argue that the destiny of an idea is in the hands of potential “users” who have the power to appropriate, ignore, modify or betray the idea. In addition to identifying the data stakeholders by considering their behaviour within the network, it will be useful to consider the profiles of data stakeholders to understand them better.

Data stakeholder profiles

Lamb and Kling (2003) examined the theoretical constructs that shape the user concept by reconceptualising the user as a social actor. They regard the user as fundamental to research and practice of information systems design, development and evaluation. Their findings indicated that the ICT user as a social actor is characterised by four main dimensions: affiliations, environments, interactions and identities. In summary, online-use practices are strongly shaped by organisation-level relationships partly in their organisational roles but also as they relate to each other. Data stakeholders as social actors have responsibilities assigned by their organisations, but also as they respond to and act as a result of their relationships within the organisation in the form of a network. The environment dimension indicates that it is critical to examine the network of relationships for exchanging data/information and use of data objects as ICT artefacts in order to understand ICT use and ICT users. Interactions refer to the exchange of information, resources and media to engage with other actors. This dimension is characterised by actors seeking to communicate in legitimate ways; they build, design and develop interactions that facilitate flow changes. Identities refer to each actor’s presentation of the self and ascribed profiles of organisational members as individuals and collective entities. Actors’ technological possessions and competencies are part of their identities. The four social actor dimensions proposed by Lamb and Kling (2003) is incorporated in the proposed framework to provide for data stakeholders as social actors’ characteristic and behaviours of connected situated individuals.

Data roles

Persons interact with data in one of three data roles: data producers, data custodians and data consumers (Strong *et al.*, 1997). Data producers (people, groups or other sources who generate data) have to deal with data generation and externalisation problems or deficiencies. Data custodians (people who provide and manage computing resources for storing and processing data) are concerned with data storage, maintenance and security problems. Data consumers (people or groups who use data) need access to data. Different data roles might assign different priorities to data quality dimensions, for example, the timeliness dimension could be considered as very important by data custodians, but less

important by data consumers; or ease of use considered as important by data consumers but less important by data custodians (Strong *et al.*, 1997; Wand and Wang 1996; Pipino *et al.*, 2002). Data quality cannot be assessed independently of data consumers who choose and use data.

A person can take on any one or more of these roles when using data. Thus, for example, a customer could be both a data object (its virtual representation) but also a data producer (capturing his/her own data) or a data consumer (using his/her own data in the case of e-commerce).

It is now necessary to consider the data object to establish what it represents.

Data object

A data object is the artefact, or combination of artefacts that represents the details of a real-world object as perceived by humans and has a structure and values. Data objects - data representations of real-world objects - are generic templates of the different organisational objects obtaining their values from data sources when instantiated through how they are used. Data objects are identified and defined during systems development by systems developers as they perceive the real-world object as well as the needs of the users (data consumers) of the data objects. A data object has a structure, i.e., the properties of the real-world object that are stored, e.g., name, age, address, diagnosis, etc. A data object can be regarded as a record, e.g., customer record, product record, patient record, etc. The focus of this study is primarily on a customer record representing the customer of an organisation and other data describing the interactions of the customer with the organisation, e.g., transaction data, consultation data, etc. All data representing the characteristics of the customer as well as data about all the interactions with the customer are considered. A customer in healthcare is a patient, for a university a student, etc.

A static view of a data object describes its structure, representation and values. Its dynamic nature depends on how it is used and this aspect is addressed in further sections.

Data quality attributes

Several studies on data quality use data quality categories and dimensions as their basis. Often, this is based on Wang *et al.*, (1994), who used factor analysis to collapse their list of 179 attributes, which they identified from data quality literature, into 15 data quality dimensions. These are grouped into four categories, describing intrinsic, contextual, representational and accessibility dimensions (Wang & Strong, 1996; Kovac *et al.*, 1997; Strong *et al.*, 1997; Abate *et al.*, 1998; Mathieu & Khalil 1998; Gendron & D'Onofrio, 2000; Turban *et al.*, 2001; Kahn *et al.*, 2002; Pipino *et al.*, 2002).

In order to provide for a more pragmatic view and also to consider the social world perspective on data quality a conceptual model was developed to present the different data stakeholders and how they relate to the data attributes of data objects and how, in return, these attributes relate to the data and real-world objects. This model provides a static view and does not provide for behavioural aspects. The model is based on Szyperski's model as applied in Ribbert *et al.* (2004) and concentrates on possible, available, requested and identified attributes. There is a real danger of presenting these attributes as fixed sets because they may not be a true representation of the complex human interaction activities dealing with data. It is, however, still useful to consider such a simplified static view to consider the different possible types of attributes. The actual research approach will address the dynamic nature of data use and data quality perceptions.

We can assume that a real-world object can be associated with a set of attributes at any given moment and these can be represented as a collection of all possible attributes for that object at that moment. Let us assume that this set of attributes is a collection of attributes that are important to one or more humans for a specific purpose, rather than an exact set of attributes. It is possible that new attributes are introduced over time, e.g., a few years ago an email address was not a possible attribute, whilst today, in the global electronic environment, it has become an essential attribute. In terms of quality this means that if the data stakeholder has access to all these attributes, they will support all current data needs to function efficiently and to support the organisation's needs. The quality of these attributes is sufficient in terms of the real-world object since it is inherently part of the real-world object, e.g., a person's name, address, age, blood pressure, eye colour, weight, etc. These attributes continuously change and are automatically updated as the real-world object responds to its environment.

The real-world object is represented in an organisation as a record, e.g., a customer or product record. This record should not be confused with a typical computer record but should be seen as a data object representing the real-world object and can in fact be represented by more than one record an organisation's customer base is represented by the collection of all customer records that only change when a customer interacts with the organisation. A data object has one or more attributes depending on its definition that may represent one or more of the attribute types indicated in Figure 2. Each attribute, e.g. name, age, balance, blood pressure, etc., has none, one or more quality attributes, e.g. accuracy, relevancy, completeness, etc., associated with it and this differs between different organisations and even between different uses of the objects within the same organisation.

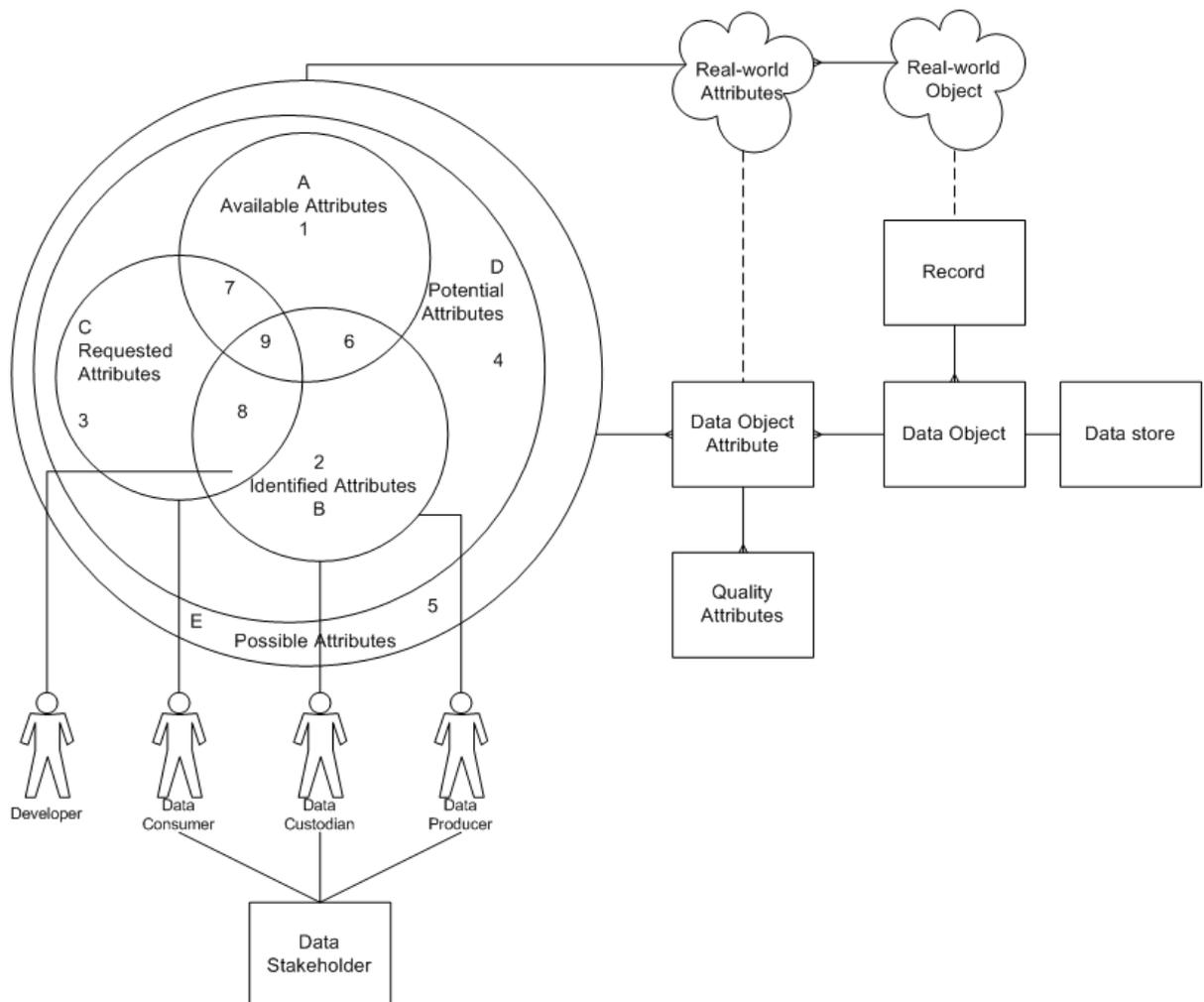


Figure 2. Relationships between data stakeholders, objects and attributes based on Ribbert *et al.* (2004)

A sub-set of the possible set of attributes is potential attributes, i.e., attributes that are currently useful for an organisation or could in future become useful for an organisation, but are not yet utilized. An example of this is an email address, an example used before. This set of attributes is subjected to environmental changes where technology adoption has a major impact on this, e.g., electronic usage of data. Potential attributes can add value to the organisation and this is important for data stakeholders to enable them to adapt to changing environment needs. A quality problem can then be when potential attributes are not available nor are they identified or requested while they could potentially have added value to the organisation. These attributes could be utilised by data stakeholders and it is a problem when they do not even recognise their potential value. This could contribute to the frustration of data stakeholders constrained by the use of data to support their functions. This can be a result of software developers omitting these attributes during software development, either because they have not been

identified as part of the data stakeholders' requirements, or because of an oversight.

Within the sub-set of potential attributes we can define three more attribute sets:

- (1) Available attributes: those attributes that are already available within the context of the environment.
- (2) Identified attributes: those attributes that were identified by software developers during development of the Information System(s) based on the requirements of the data stakeholders and the developers' perceptions of the real-world object (compare with Wand & Wang). In addition to the quality of the data representation of the objects, it is also important to consider the mapping of the organisation's object, e.g., customer, to its IS data representation (customer record).
- (3) Requested attributes: those attributes required by data stakeholders and which are necessary to perform their organisational functions.

The intersections of these sets have different meanings within the organisational context and are not discussed in detail in this paper. The ideal for any organisation would be when the potential, available, identified and requested attributes sets are equal. These attributes will then correctly reflect changes that they are subjected to over time. The quality attributes that may be influenced are the intrinsic, contextual, representable and accessible quality attributes. In most organisations the ideal situation described above seldom applies and this should be investigated. Since this directly reflects on how data stakeholders use data to support their organisational functions, it could deal with their perplexities and identify possible obstacles.

Different data stakeholders will have access to different types of attributes. The data consumer can only obtain identified, requested and available attributes although they may in fact request attributes that are not available or that have not been identified. This could then be perceived by the data consumer as a quality issue. Data producers capture values for identified, available and requested attributes but may in some cases not have values for those attributes that are available but have not been requested or identified. The role of data custodian refers to the person(s) who take on the responsibility of "looking after" the requested, available and identified attributes. The custodian cannot take the responsibility for attributes that are available and that were requested if these have not been identified.

Inscriptions

A data object is not only a static template with structure and values which exist by itself, but it is formed by the way data stakeholders use it. These patterns of behaviour are inscribed in the data object.

Inscriptions are attempts to inscribe patterns of use or behaviour in, for example, artefacts, work routines, legal documents, standards, procedures and other institutional or organisational arrangements (Monteiro, 2000). Based on Callon (1986) inscription can be described as a “*process of creating technical artefacts that would ensure the protection of the actor’s interest*”.

During software development the “*programs of action*” for the users are inscribed in the data object based on the perception of how the data object will be used and this then defines the perceived roles of the data stakeholders. Assumptions about the required competencies and roles of the data stakeholders are made that means that these roles and competencies are delegated to the components of the socio-technical network. The data object can for example “*resist*” responding in the way expected by the data stakeholder such as when it does not allow a value to be entered based on its validation criteria. Data stakeholders may also use data objects in unanticipated ways by, for example, bypassing validation criteria or finding creative ways to enter data values in other fields such as entering a comment in an address field, etc.

Data stakeholders interact with data objects by using them as intended or unintended according to their understanding of how data should be used during their daily activities. This could result in intended or unintended consequences as reflected by the outcome of the action, e.g., by how they produce or consume data to compensate for quality problems. The inscriptions not only influence the use of the data objects based on the data stakeholder’s own competencies and assumptions, but may be influenced by factors of the environment in which the data stakeholder operates, as well as by actions of other actors. Data stakeholders interpret data as information in the context of their own existing knowledge which places it on the pragmatic level of the semiotic model (Swan, *et al.*, 2000). There may be restrictions as to how data is used, e.g. decisions based on incomplete data and not having the means or time to deal with what the data lacks. The outcome of an action therefore results in some consequence that may also be influenced by interaction with other actors or by these actors’ behaviour. Actors may influence each other by convincing each other of their interests and how that may benefit them. All of these actions may influence the way that data objects are used and the data object’s “response” to this is then determined by its inscriptions. It is therefore necessary to not view data stakeholders and data objects in isolation, but rather as they “respond” to each other during interactions.

Networks for data quality

Data stakeholders interactions with data objects and can be represented in a network with the data stakeholders and data objects the nodes of the network. A network can be regarded as a coordinated system of people and/or things that communicate with each other and work together as a unit or system. The term networking refers to the building or maintaining of relationships to exchange

information or share access to a central store of information. These relationships may result in advantages such as job or business opportunities.

In an organisation the data stakeholders and data objects are all potential actors in the network and by being able to align such a network to an interest that results in data quality, the actors will contribute to an improved quality of data.

Data object and stakeholder network

The diagram in Figure 3 represents all the possible nodes of a data network for an organisation and how these nodes could interact with each other. At this stage it does not provide for technology and also does not specifically address the contextual factors of the organisational environment. Organisational data stakeholders interact with the data objects in one of the data roles. Instances of the data object are then created or modified.

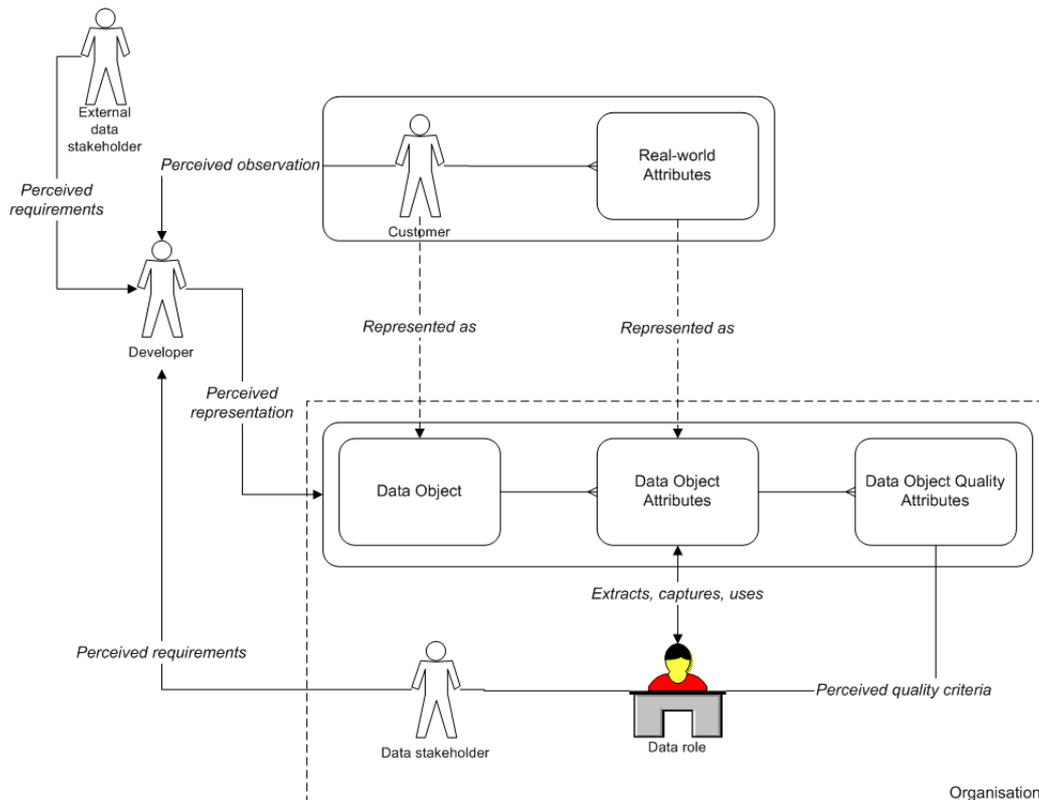


Figure 3. Data quality network

Figure 3 represents the possible relationships between the developer(s) and the real-world object and its representation and usage within an organisational context. External parties could be partners of the organisation with whom they want to share data, e.g., data suppliers in the case of suppliers of products in an e-commerce environment. It could also be the government where specific

regulations need to be considered for the use of the data object by the organisation. An important aspect as highlighted by Wand and Wang (1996) is that developers also perceive real-world objects in a particular way that will be influenced by their experience, background, etc. Developers have to integrate these perceptions with the perceived requirements. There are therefore two possibilities for incorrect and/or incomplete translation of requirements that may have a long-term impact on the use of these objects by the organisation. In addition to defining the data object(s), the developers also need to consider the data quality attributes that are required by the data stakeholders and also how this quality attributes will be incorporated in the system (examples could be data validation in program code, triggers and procedures in database systems etc.). If the data quality is not anticipated, considered or not correctly translated then it will have an impact on the quality of the data values for that object that will have a long-term impact on its usage.

The data object is made up of different components and these are discussed next in terms of a customer.

Customer data model

Data about customers appears in different places in an organisation. Figure 4 illustrates the different components of customer data as a conceptual model. This model provides a framework that can be used to investigate the different components of customer data.

Figure 4 specifically illustrates how the customer, as a real-world object, is decomposed into its different data components. The data details can either be captured details, when data of the customer is captured by the organisation, or knowledge about a customer that is not formally captured by the organisation's information systems. Captured details could be the customer's history, personal, interaction or transaction details. These details may be distributed into different data objects that may be part of one or more information systems. The data objects are stored in one or more data stores that could be a computer store such as a database and/or other media such as paper files, audio tapes (recording of telephone calls or consultations), etc. The customer's history, interaction and transaction details will include, e.g., data about the products that the customer has bought or inquired about. The data stakeholder has internalised knowledge about specific customers, customers as a group, etc., and this knowledge is embedded in the data stakeholder. The data stakeholder integrates this knowledge with the data obtained when producing or consuming data from the captured data object of the customers. Data stakeholders only interact with real-world objects to produce or consume data when required by some event, e.g., to handle an inquiry, or if instructed by the organisation, e.g., to compile a list of all customers with outstanding balances.

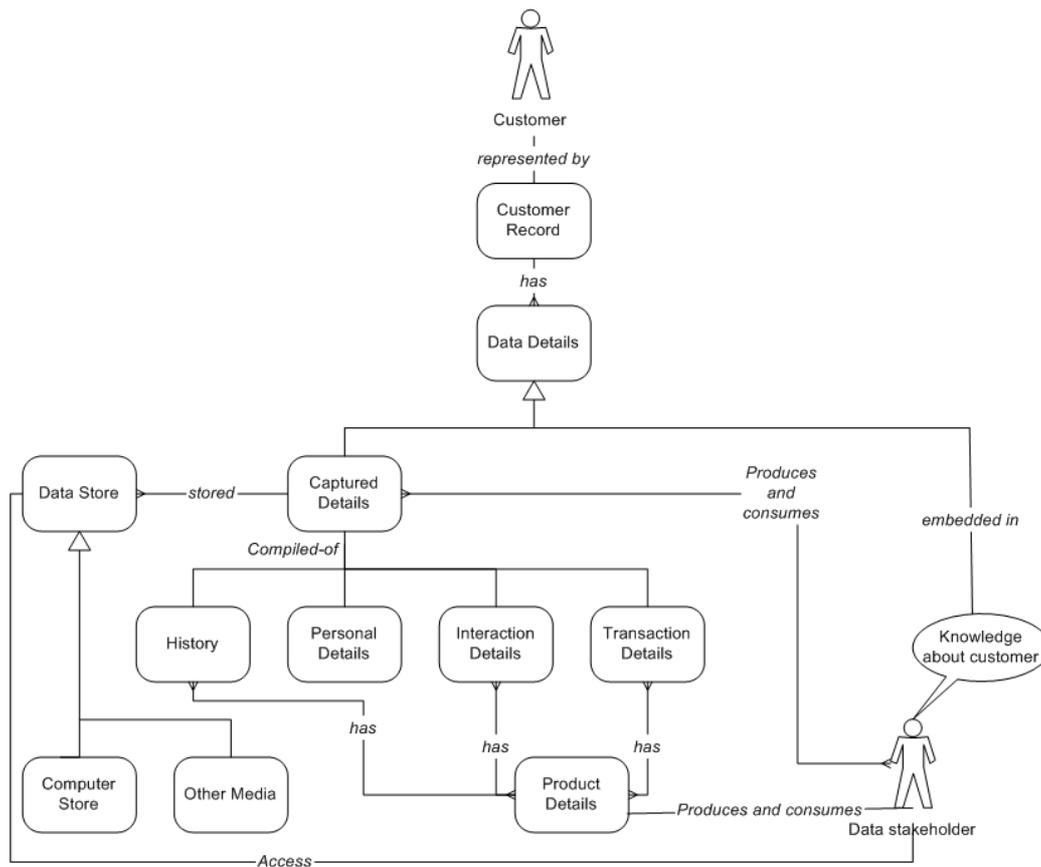


Figure 4. Customer real-world object represented by its different data components.

Data stakeholders interacting with data objects

Human actions are viewed as intentional allowing actors the freedom to consciously decide about their actions to achieve a specific goal (Johnston, 2001). There are essentially two main views (ibid.) on the nature of intentional action, viewing action as deliberative or situated. Deliberative action is not considered in this study but situated action can shed light on how data stakeholders act when confronted with data quality issues where they may not have an existing abstract model of their world. According to situated action theory, the stakeholder would make use of only sense data directly from its situated, embodied ground view with little processing by using a limited number of largely reactive response actions. It also gives a more prominent role to the environment as an agent in achieving intentions. The stakeholder responds to aspects of its environment which in turn responds to the stakeholder's actions.

How data stakeholders interact

How practitioners experience data quality was the main focus of Lee's (2003) five-year longitudinal study and his findings indicated that:

“experienced practitioners solve data quality problems by reflecting on and explicating knowledge about contexts embedded in, or missing from, data.”

Lee (2003) found that practitioners' context-reflective mode of problem solving plays a pivotal role in crafting data quality rules. Often these rules are the result of unconventional ways that bypass standard organisational procedures. Data stakeholders, when confronted with some quality issue, often have to resolve it by improvising, i.e., finding a solution on the spur of the moment based on prior experience with a similar problem. This results in new, untested and sporadic problem solving and is at the heart of what this study attempts to do. It is therefore necessary to focus rather on the rules for exceptions than available and standard practices.

Data stakeholders' reflection-in-actions refer to how these rules are used when dealing with data quality problems. Data quality is highly contextual and the context as suggested by Lee (2003) is a differentiator and relationship builder, specifying the relationship between the contents and its environment determining how activities are influenced.

The situation's back-talk is the situation's answer to the acts of the practitioner. A reflective practitioner is able to handle situations characterised by uniqueness, complexity and conflicts because of his ability to reflect-in-action. He is thus capable of making sense of the situation he has never met before. Relevant, up-to-date and available data will allow data consumers to make better decisions and to use their knowledge to better respond to the context of their environment.

Improvisation should also provide another view of stakeholders' behaviour in specific situations, how they interact with each other and specifically within the context of this study and how they deal with data quality in the absence of clear guidelines. Ciborra's (1999) work on improvisation is relevant here, but, in the interest of brevity, will not be further explored.

How actors deal with data quality

In order to understand better how stakeholders interpret their interactions with other stakeholders and their environment, the human characteristics of stakeholders need to be considered. Humans' knowledge influence how they perceive and interpret their environment, interactions and the way they will approach their actions to achieve a specific goal. Data stakeholders interpret their perceptions based on their current knowledge base and Lee and Strong's (2004) modes of knowledge - knowing-what, knowing-how and knowing-why - as well as the data skills referred to by Chung *et al.* (2002) are relevant here. Lamb and Kling (2003) emphasized the importance of profiling users of an information

system as social actors who are characterised by their affiliations, environments, interactions and identities. Since stakeholders do not have the same knowledge base and they respond to their environment and each other in different ways, it is not possible for organisations to provide a set of guidelines for data stakeholders guiding them on how to use data objects to contribute to its quality. Several authors (Ciborra, 1990; Cunha *et al.*, 1999; Seham, 2001; McKnight and Bontis, 2002; Bansler and Havn, 2004; Vera and Crossan, 2004) consider improvisation as situated performance where thinking and action emerge simultaneously but differently for each person. Since social sciences use communication as a means of constructing the social world, Flores's (1997) communication through networks of commitment and action would be considered to understand how the actors "get things done" and "share interpretations". Lee (2003) identified specific contexts that dictate how data stakeholders frame, analyse and solve data quality problems.

Data quality should not be regarded as simply an intuitive consideration during an action, but requires an awareness of its importance through training and organisational guidance and support. Also, in order for improvement to take place, spontaneous actions need to be analysed in terms of consequences and data stakeholders will require the necessary tools, knowledge and resources to prepare them for improvisation.

All the above concepts are incorporated in a data quality research framework that is presented and discussed next.

Data quality research framework

The main components are the data stakeholder and data objects, each with its associated characteristics and then the interaction between these two entities represented as the "how" of the interaction. These are represented by figure 5.

Data stakeholders interact with data objects as they perceive these objects in their real-world and representational states. Data objects have attributes and inscriptions representing the attempts to inscribe patterns of use by humans. Another characteristic of the data object is that it has data of different degrees of quality, for example, the quality of its structure in terms of how it was defined during development; quality of the data values of the different instances; and the quality of how these values are represented to data consumers. Data stakeholders have profiles and interact with data objects in one or more data roles. They may have power that they may use in their relationships with other stakeholders and they have resources. These resources are based on their existing knowledge and skills and these should influence the way they interact with the data objects. Data stakeholders use different approaches when interacting with data objects and how they interact is influenced by how they respond to their environment and for that they use their knowledge and previous experiences. They may improvise and will

communicate with each other. Incriptions are inscribed by designers and developers. During the interaction with the object, these inscriptions are enacted as intended or wrongfully, but no new inscriptions result from the interaction. All of the above are influenced by the context or environment of the organisation.

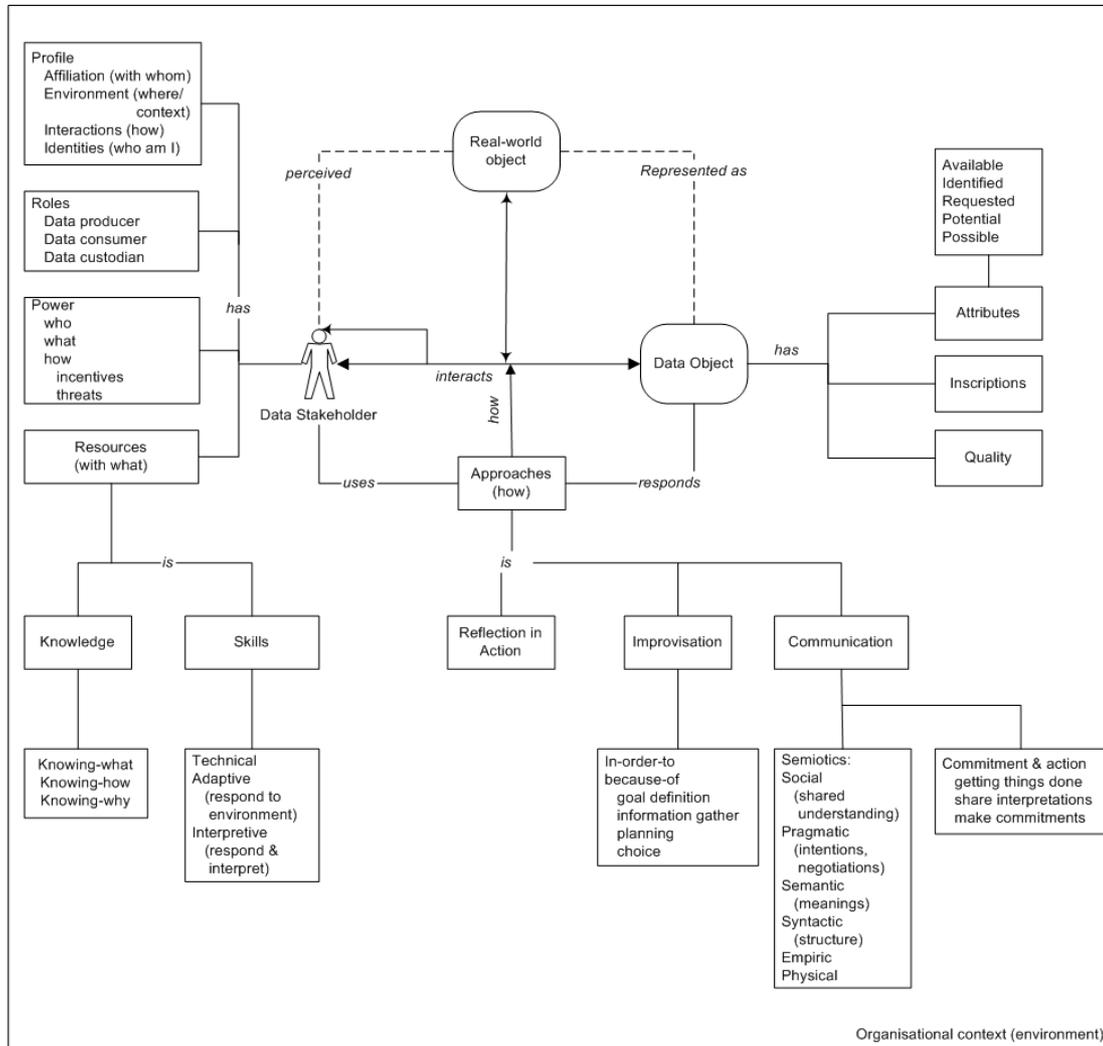


Figure 5. Data quality research framework

Conclusion

A data quality research framework as presented in figure 5 has all the theoretical aspects incorporated that will be considered during the research process. By following the actors as they deal with data quality during their interactions with data objects, some of these aspects may be noted to then be interpreted and finally reflected upon. Research questions were generated from the framework that was posed to the data, so to speak. These “data questions” were then rephrased into

questions that were used during the interviews with the different stakeholders. The responses were recorded and presented in terms of the framework for analysis. This allowed the researcher to deal with all the complexities identified in a manageable manner to include as much of the issues as possible during data collection. The next step will be to validate the framework to establish its usefulness as a tool for investigating data quality. The use of the framework should also contribute to the interpretation of the findings. Reflection on the research results and process should provide sufficiently for drawing conclusions about the validity of the framework in terms of data quality research. The contribution of this research is the emphasis on the social dimension of data quality that changes the focus away from the quality attributes of data to how data stakeholders deal with data quality in practice when interacting with the data. The contribution of this paper is the incorporation of social aspects in a data quality research framework that can be used when researching data quality.

Acknowledgements

This paper is based on research funded by Academy of Finland grants no. 39187 (INDEHELA-Methods,19982001), 201397 and 104776 (INDEHELAContext, 2003, 20042007): www.uku.fi/tike/indehela

References

- Abate, M.L., Diegert, K.V., Allen, H.W. (1998). "A Hierarchical Approach to Improving Data Quality", *Data Quality*, vol.4 no. 1 <http://www.dataquality.com/998abate.htm>, last accessed on 02/11/07
- Atkins, M.E. (2001). "The time has come for enterprise data quality management", the data administration newsletter, <http://www.tdan.com/i015ht03.htm> last accessed on 02/11/07
- Bansler, J.P., Havn, E.C. (2004). "Improvisation in information systems development", part of: *Information Systems Research, Relevant Theory and Informed Practice* Kluwer Academic Publishers Group, Dordrecht. 631-646
- Callon, M. (1986). "Some elements of a sociology of translation: domestication of the scallops and the fisherman of St. Brieu Bay", *In Power, action and belief: A new sociology of knowledge?*. Law, J. (Ed.), Routledge and Kegan Paul, London, 196-233.
- Chung, W.Y., Fisher, C., Wang, R.Y. (2002). "What skills matter in data quality?", *proceedings of the seventh international conference on information quality*, Nov 2002, MIT, USA.
- Ciborra, C. (1999). "Notes on Improvisation and Time in Organizations", *Accounting, Management and Information Technologies* vol. 9.
- Cunha, M.P., Cunha, J.V., Kamoche, K. (1999). "Organizational improvisation: what, when, how and why", *International Journal of Management Reviews*, vol. 1 no.3, 299-341.
- Flores, F. (1997). "The leaders of the future", *in beyond calculation: the next 50 years of computing*, P.Denning, R. Metcalfe (eds), Copernicus and imprint of Springer-verlag.
- Freeman, R.E. (1984). "Strategic management: a stakeholder approach", New York: Basic books.

- Gendron, M., D'Onofrio, M. (2000). "An exploratory study investigating data quality in the healthcare industry: what are the implications for data warehousing?", *Proceedings of the Americas conference on information systems, 2000, Long Beach, USA*.
- Helfert, M., Herrmann, C. (2002). "Proactive data quality management for data warehouse systems: a metadata based data quality system", *Proceedings of the 4th international workshop on design and management of data warehouses (DMDW 2002) in conjunction with CAiSE 2002, Toronto, Canada, 97-106*.
- Johnston, R.B. (2001). "Situating action, structuration and actor-network theory: an integrative perspective", in *proceedings of the 9th European conference on information systems (ECIS 2001)*, Bled, Slovenia, 232-242.
- Kahn, B.K., Strong, D.M., Wang, R.Y. (2002). "Information quality benchmarks: product and service performance", *Communications of the ACM*, vol. 45, no. 4.
- Kovac, R., Lee, Y.W., Pipino, L.L. (1997). "Total data quality management: the case of IRI", *Proceedings of the 1997 conference of information quality*.
- Lamb, R. Kling, R. (2003). "Reconceptualising users as social actors in information systems research", *MIS Quarterly*, vol. 17, no. 2.
- Lederman, R., Shanks, G., Gibbs, M.R. (2003). "Meeting privacy obligations: the implications for information systems development", in *New paradigms in organisations, markets and society: proceedings of the 11th European conference on information systems*, Naples, 19-21 June, 2003.
- Lee, Y.W. (2003). "Crafting rules: context-reflective data quality problem solving", *Journal of managing information systems*, vol. 20, no. 3, 93-119.
- Lee, Y.W., Strong, D.M. (2003). "Process knowledge and data quality outcomes", *proceedings of the eighth international conference on information quality (ICIQ-03)*, M.J. Eppler, M. Helfert (eds). November 7-9, MIT, Cambridge, USA.
- Lillrank, P. (2003). "The quality of information", *International journal of quality and reliability management*, vol. 20, no. 6, 691-703.
- Linde, A., Linderöth, H., Räisänen, C. (2003). "An actor network theory perspective on IT-projects: a battle of wills", In *ALOIS proceedings 2003, Action in language, organisations and information systems*, in Golkuhl, G. Lind & Ågerfalk, P.J. (eds), University of Linköping, pp. 237-250.
- Loshin, D., Inbar, D. (2002). "Integration and the Data Quality Imperative", *The Data Quality Monitor*, http://b2b.ebizq.net/ebiz_integration/loshin_1.html last accessed, 02/11/07
- Mathieu, R.G., Khalil, O. (1998). "Data Quality in the Database Systems Course", *Data Quality Journal* <http://www.dataquality.com/998mathieu.htm> last accessed on 02/11/07.
- McKnight, B., Bontis, N. (2002). "E-improvisation: collaborative groupware technology expands the reach and effectiveness of organizational improvisation", *Knowledge and process management*, vol. 9, no. 4 219-227.
- Monteiro, E. (2000). "Actor-network theory", in C.Ciborra (ed), *From control to drift. The dynamics of corporate dynamics of corporate information infrastructures*. Oxford University Press.
- Neus, A. (2003). "Evolving knowledge: empowering information users", *Proceedings of the 2003 international conference on information quality (MIT IQ Conference)*, M. Eppler, M. Helfert, L.Pipino and A.Segev (eds), 7-9 November 2003, MIT, USA.
- Pipino, L.L., Leem, Y.W., Wang, R.Y. (2002). "Data Quality Assessment", *Communications of the ACM*, vol. 45, no.4. 211-218.

- Pouloudi, A., Gandecha, R., Atkinson, C., Papazafeiropoulou, A. (2004). "How stakeholder analysis can be mobilized with actor network theory to identify actors". *IFIP WG 8.2 Organizational and Societal Issues of Information Systems Conference*. 15-17 July 2004, Manchester, UK.
- Redman, T.C. (2003). "Financial reform begins at home", *In proceedings of the eighth international conference on information quality (ICIQ-03)*, M.J. Eppler, M. Helfert (eds). November 7-9, MIT, Cambridge, USA..
- Ribbert, M.R., Niehaves, B., Dreiling, A., Holten, R. (2004). "An Epistemological Foundation of Conceptual Modeling". *Proceedings of the twelfth European Conference on Information Systems*. June 14-16. Turku, Finland.
- Rothenberg, J. (1996). "Metadata to support data quality and longevity", *IEEE Software*, http://www.computer.org/conferences/meta96/rothenberg_paper/ieee.data-quality.html, last accessed on 02/11/07
- Russom, P. (2006). "Taking Data Quality to the Enterprise through Data Governance", *The Data Warehouse Institute survey report*.
- Shanks, G., Corbitt, B. (1999). "Understanding Data Quality: Social and Cultural Aspects", *10th Australasian Conference on Information Systems*, Hope B and Yoong P (eds), Proceedings of 10th Australasian Conference on Information Systems, 785-797. Wellington, New Zealand: Victoria Univeristy of Wellington.
- Shanks, G., Darke, P. (1998). "A framework for understanding the quality of data in data warehouses", *Proceedings of the MIT conference on information quality*, I. Chengilar-Smith, L. Pipino (eds), Boston, November 1998, 247-264.
- Strong, D.M., Lee, Y.W., Wang, R.Y. (1997). "Data quality in context", *Communications of the ACM*, vol. 40, no. 5.
- Swan, W., Langford, N., Watson, I., Varey, R.J. (2000). "Viewing the corporate community as a knowledge network", *Corporate Communication*, vol. 5, issue 2, 97-106.
- Turban, E., Rainer, R.K., Potter, R.E. (2001). *Introduction to Information Technology*, John Wiley & Sons, Inc.
- Vassilidadis, P., Bouzeghoub, M., Quix, C. (1999). "Towards Quality-Oriented Data Warehouse Usage and Evolution", *in proceedings of the 11th conference on Advanced Information Systems Engineering (CaiSE99)*, Germany.
- Vera, D. Crossan, M. (2004). "Theatrical Improvisation: Lessons for Organizations", *Organization Studies*. vol. 25. 727-749
- Wand, Y., Wang, R.Y. (1996). "Anchoring data quality dimensions in ontological foundations", *Communications of the ACM*, vol.39, no. 11.
- Wang, R.Y., Strong, D.M. (1996). "Beyond Accuracy: What data quality means to data consumers", *Journal of Management Information Systems*, vol. 12 issue 4.
- Wilson, T.D. (2002). "The nonsense of 'knowledge management'", *Information research*, vol. 8, no. 1.

Criteria for measuring and comparing information systems

Joel Palmius
Mid Sweden University
joel.palmius@miun.se

Abstract: Whether designing a new system or evaluating an old one it could be useful to be able to compare the system with another system, intended or existing. One way to evaluate and compare information systems would be through a set of criteria encompassing factors thought important. For such criteria to be useful they need to be operational and measurable. This article presents a list of criteria found in literature, combined with a few criteria not found, and a categorization. The criteria are presented in a collected hierarchical model organizing them into the categories of Organization, Individual, Information, Technology and Systemics. It is concluded that the criteria model may be useful, for example as a checklist during design, but that it needs to be operationalized, and be exposed to practice and empirics.

Keywords: Information system, evaluation, measurement, comparison, criteria

Introduction

When confronted with an information system (IS) and an unspecific expectation to make the IS "better", it could be useful to measure the current IS and compare it with another IS, intended or existing. With operational criteria for measuring an information system, a foundation can be laid for improving the IS in the aspects of which it is found lacking.

Further, an information systems designer needs to know what the goal is, and a buyer of the services of the designer needs to know whether the goals have been fulfilled. With a set of criteria for deciding this, there could be a checklist before, during and after a design phase: Does the system do what it is supposed to do, and to what extent does it do it as compared with, for example, a previous system?

When searching for criteria which characterize an information system, I have not yet been able to find a complete model which encompasses all the aspect I find interesting. In the literature section below, I will list those models I have found (and which are relevant for the discussion).

The lack of encompassing models is part of what makes this article relevant: I have not found a usable overall model, and the models for measuring or evaluating details did not take each other into account when they were formulated. A summary and reformulation is thus useful.

Purpose of the article

The purpose of this article is to provide a collected framework for criteria for the measuring and comparing of information systems.

Assumptions

In the following discussion, a few assumptions will be held. First, the definition of what constitutes a good system varies between stakeholders, perspectives and system purposes. To paraphrase Ashby (1962), there is no information system which is good in an absolute sense.

Second, because of the assumption of relativity, it is necessary to choose a perspective from which to conduct the discussion. In this article a managerial perspective is chosen.

Thirdly, it is assumed that a healthy information system will require that all stakeholders are reasonably satisfied. Thus even with a managerial perspective, we need to look at what is good for the participants in the information system.

Terms

In this article, an information system is all that, abstract or not, within an organization that contributes to and shapes the distribution of information. Humans are parts of the information systems rather than users of the information system. There is no such thing as information system without a human, but it is perfectly conceivable to have an information system without a single computer. (Palmius J, 2005b)

Other core terms used here are "evaluation", "measurement" and "comparison". The measurement is an observation and quantification of a phenomenon, as formulated in the criteria list below. The evaluation is a measurement paired with

an observation of what would be desired (by the person doing the evaluation). The comparison is putting two evaluations against each other.

Method

The procedure for producing the criteria framework has been the following:

First I started with a broad search on the net for terms such as “good information system” and “evaluation of information system” to find encompassing models fitting what I wanted (a model for the evaluation of information systems). This basically resulted in the DMSM (DeLone W, McLean E, 1992) mentioned more in detail below.

Secondly I tried arranging criteria according to time (pre-hoc measurement, normative statement, post-hoc evaluation), but decided it was not a good structure, because it was difficult to place criteria.

Thirdly I drafted a rough hierarchy based on a organization-individual-technology-systems view and found that this made it easier to categorize criteria. Along with finding new criteria I placed them into the top categories, and made sub-categories from what to me seemed to be the major groups found in literature.

Late in the work I moved all criteria related to information from the organization category to a category of its own.

Criteria from literature

The following is a summary of what I find to be important literature for my purpose: To find a set of operational criteria for evaluating IS in an organizational sense.

There are several models for evaluating information systems, and a plentitude of models for evaluating specific details within an IS. Searching on Google's aggregated article database (<http://scholar.google.com>), one can see that most of the literature for evaluations falls within one of these categories:

- Economical benefit, such as return on investment
- Usability measurements, mainly of interfaces
- Measurements of user and/or customer satisfaction

Literature also exists, but in significantly lesser degree, for measuring organizational benefits, systems quality and performance (for performance, lesser degree on an organizational level: there is much literature concerning performance on a technology level).

Note that what are treated here are evaluational aspects. There also exists vast amounts of normative literature for how information systems should be organized,

but that is outside the scope of this article, unless the normative criteria can be reformulated in an evaluational fashion.

Models specifically for evaluating IS in general

One of the most cited models for measuring information systems success is the DeLone and McLean Information Systems Success Model (DeLone W, McLean E, 2003) (DeLone W, McLean E, 1992), from now on referred to as DMSM.

The DMSM has a basic model consisting of six categories of IS success:

- Systems quality
- Information quality
- Use
- User satisfaction
- Individual impact
- Organizational impact

The model has later been extended by several researchers, for example by Seddon (1997) who concluded, among other things, that the meaning of "use" in DMSM needed to be better defined. Further, the validity of the DMSM (and of Seddon's extension) has been empirically studied (Rai A, Lang S, Welker R, 2002), and it was found that both DMSM and Seddon's extension were supported.

The criteria presented in this article could be said to be a model of information systems success. They do however differ in the definition of what constitutes an information system, and in their goal: the explicit measurability.

Now, it should be noticed that there are also operationalizations of the DMSM. One such operationalization is the SERVQUAL instrument, which has been shown to be a functional tool for measuring service quality in IS (Pitt L, Watson R, Kavan B 1995). SERVQUAL is however limited to service quality. This is in this article seen as only one aspect of the IS. Further I remain unconvinced that a questionnaire consisting of 45 likert scales, divided along preferences and perceptions, is a good measure of the quality of a whole IS.

Torkzadeh and Doll (1999) has performed a study concerning perceived impacts of information technology on work life, in which a set of four criteria were derived from a larger set of questions. These criteria were task productivity, task innovation, customer satisfaction and management control. It should be noted that the tool only measured the opinions about whether a technological artifact had had a good impact, there were no factual measurements.

Martinsons et al (1999) have developed a balanced score card approach to measuring a set of criteria from four different points of view. These points of views are business value, user orientation, internal process and future readiness. Each perspective contains a set of criteria. For example does the future readiness

perspective contain criteria like age distribution of IS staff, and expertise with specific emerging technologies.

Jiang and Klein (1999) have studied evaluation of IS from the users' point of view and has summarized earlier literature into four categories of criteria: Performance issues, decision quality, personal impact and organizational impact. While the study was focused on measuring how important users felt these criteria were, the list of criteria is interesting in itself because of its concreteness.

Irani (2002) has categorized a number of semi-operationalized criteria. He has first divided the criteria into three major categories: strategic, tactical and operational benefits, and then examined the criteria from what kind of benefit they bring. He sees that benefits can be financial, non-financial and intangible. It should be noted that his article, however, is focused at measuring whether an investment is justifiable. Still, his categorization is interesting since it lists some 30 criteria which can be reformulated to fit into the current context.

Auvo Finne (2005) has reviewed, summarized and extended a number of (mainly normative) selected documents concerning IS quality. He has produced a model for ensuring and evaluating IS quality.

International standards

There are several ISO standards which can be relevant to this discussion. The ones most relevant are those dealing with software development and with quality management. There are likely also other ISO standards concerning quality and organizations, which could be interesting although peripheral. I have not considered these, as the point of this discussion is to find criteria relating to the IS specifically.

ISO 9000 (ISO 9000, 2005) deals with the management of quality and defines terms and fundamentals within the field. It does not specifically deal with the quality of IS, but rather with quality management systems in general, or in other words the construction of a system to manage quality within an organization. However, several terms are directly transferable as criteria. Of particular interest are the term definitions concerning quality, management, organization, and documentation.

ISO 9126 consists of four parts all describing aspects of quality and software engineering. ISO 9126-1 (ISO 9126-1, 2003) describe an overall quality model for the product quality of software products. Terms such as functionality and maintainability are here defined. ISO 9126-2 (ISO 9126-2, 2004) describes external quality metrics, or in other words how well a certain piece of software behaves within the system it is placed. ISO 9126-3 (ISO 9126-3, 2004) describes internal quality metrics, or in other words how well a piece of software behaves when studied as such. ISO 9126-4 (ISO 9126-4, 2004) describes how the models and the metrics can be used in quality work. All the four parts of the ISO 9126 series use the same terms for describing quality.

Information and record quality

One of the problems with describing a general way for evaluating information systems is that the information within the system looks very different from case to case. I will thus make a slight separation between system and information here: The information system is something that operates on and with information.

The term "information quality" is by necessity rather subjective, or at least dependent on situation: It is more a question of what is applicable in a certain setting than what is objectively good.

However, some aspects of information quality can be said to be generally applicable. One such aspect is that of archivability. It has been noted (Borglund E, 2006) that in order to retain quality in the transformation of information into records, the records have to retain certain properties, such as authenticity and reliability. It is my view that these criteria can as well be applied to the source material (the information). Borglund (2005) further lists sixteen criteria for attaining trustworthiness in e-records. Several of these will be used below. Borglund and Öberg (2006) further put forward the notion that one of the main purposes of records is that of "evidence". This will be taken into account although reformulated.

Models for evaluating details in an IS

There are also several models for evaluating parts of an information system (that is, parts of what in my definition constitutes an information system). Many of these relate to what in the categorization below is called "technology".

One big category of evaluation details is the area of HCI literature and usability measurements. These measure and study the user interaction with the interface to the technology. One of the most influential books concerning the measurements is written by Nielsen (1993), in which he defines usability as a set of measurable factors consisting of "learnability", "efficiency", "memorability", "error" (or free from) and "satisfaction". Here he also stresses the important issue that usability is not something absolute: Rather it is something highly dependent on what user we are talking about, and in which context.

While Nielsen's recommendations and definitions are primarily written to fit graphical user interfaces, I find that the aspects are generalizable enough to be useful to be applied to information systems as a whole.

Another significant part of the available literature deals with software quality. Apart from the normative literature concerning software development, the ISO 9126-x standards documents provide a comprehensive framework for software evaluation. These documents are recent and can be assumed to be built on the best concurrent practice.

In the non-technical literature concerning quality of IS, economics takes a significant part. Hitt and Brynjolfsson (Hitt L, Brynjolfsson E 1996) defines three

basic criteria for evaluating whether information technology is valuable. According to them, the three major criteria would be productivity, business profitability, and consumer surplus. While the major point of the referenced article is to decide whether IT investments are good for all three of these criteria (they find that they are not), the article is still interesting from the point of their definitions of important criteria.

Another non-technical area concerning IS, is that of IS use. I am aware of this area, but have elected to exclude it despite its prominence in literature. The reasoning behind this is that use is a product of system quality, not the other way around. Thus it would be counter-intuitive to measure use as an independent variable for determining quality. This decision might be changed eventually, but for now IS use will not be taken into account.

Patricia Rogers (2007) has compiled a list of evaluation literature with implications for action research. Several sections in this bibliography describe meta-evaluation frameworks for things such as organization and policy. Describing these meta-evaluation frameworks here is however beyond the scope of the paper.

Normative literature

Since most of the literature within the IS field is normative (or at least this is my impression), there is no lack of sources to search among. The question rather becomes what to choose and what is relevant for a list of evaluational criteria. In the end I have limited this section to a few major (if a bit dated) systems model and a contemporary collection of design guidelines.

Within the systems field, there is an implicit language which is more or less agreed upon. This language contains terms such as system, system boundary, feedback loops and viability. Many of these terms can be converted into points of observation when studying an information system. One example of a book which summarizes these terms is that of Flood and Carson (1993).

Further within the systems field, there are classical systems models, or models for analyzing systems. Of these, I will here mention the Viable Systems Model, VSM (Espejo R, Harnden R, 1996), and the Living Systems model (Miller JG, 1978). Both of these are rather dated and are not used to any significant extent in contemporary systems design. They do however provide good models for analyzing systems to see if something is lacking. They both list functions which are thought necessary for a viable system.

Another normative approach which has aged with more grace is the Soft Systems Methodology, SSM, (Checkland P, Scholes J 1997). SSM is still frequently referenced in contemporary organizations- and systems development literature. For the sake of evaluation, SSM provides a good basis for identifying stakeholders and cultural problems.

There are of course other systems models available. I am aware of these. Of particular note might be critical systems and multi-modal systems approaches. At this point in time I do however not think they would contribute to the end model, but I'm open for later inclusion.

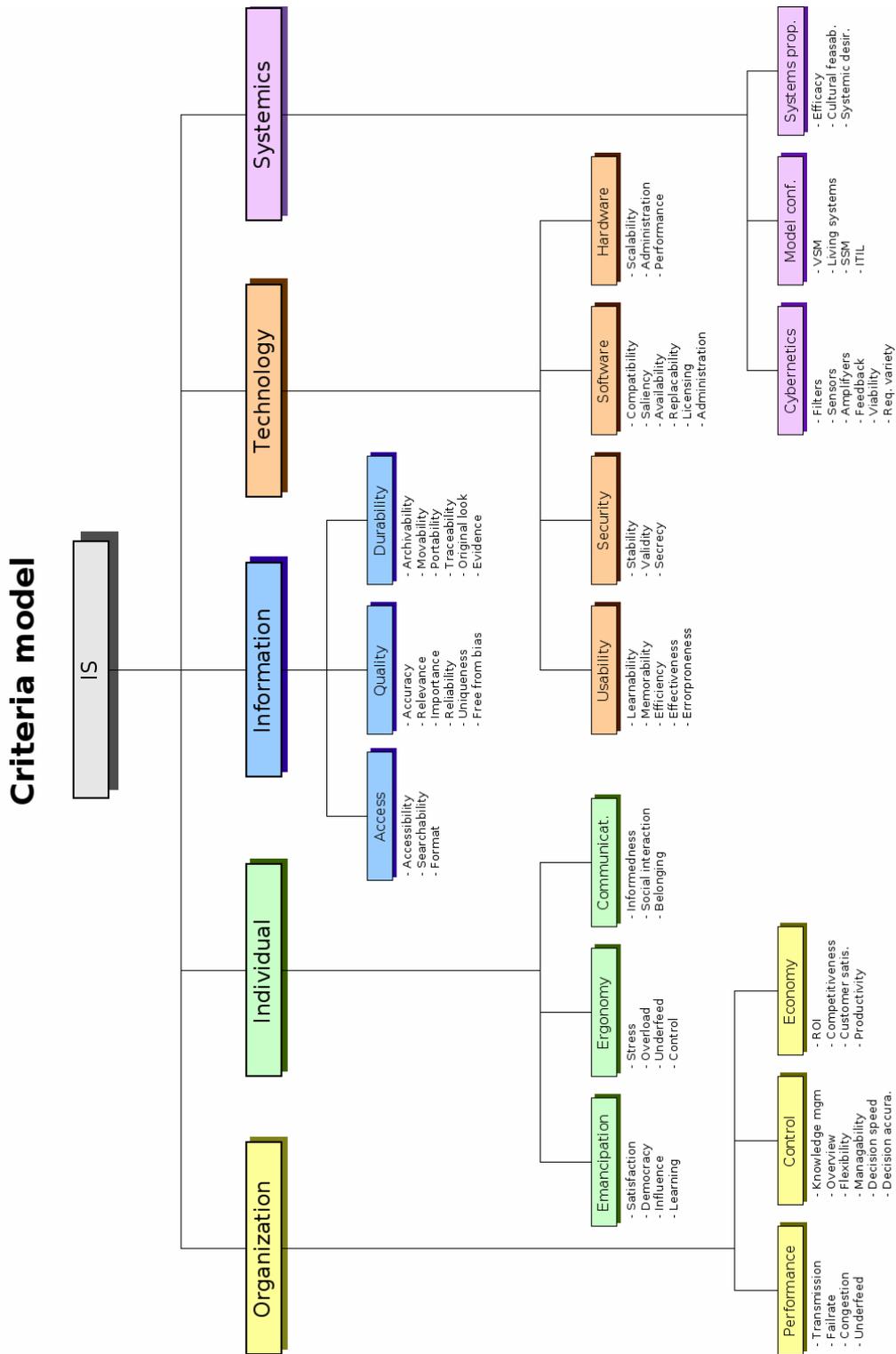
Finally, to return to current time, I have opted to include a contemporary reference framework, The Information Technology Infrastructure Library, ITIL (IT Library 2007). According to its own words, ITIL is a collection of best contemporary practices for managing an IT operation. This collection or library provides a good base for checking model conformance with contemporary practices.

Categorization of criteria from literature

Literature defines many criteria for what characterizes a good information system. Below I have summarized these criteria according to a categorization derived from an organization-individual-technology-policy model, the Syntegrity-4 (Holmberg S, 2001).

Note that some criteria has been reformulated and/or been given new names to fit into the tables. Below each table I will list criteria divided into "literature" (criterion for which there is a direct reference) and "not in literature". For the latter, I want to stress that I am reasonably certain it in fact exists in literature, but that I have not yet decided upon a good reference.

The diagram on the following page summarizes the criteria framework. In the following, the major divisions will be described shortly. Tables with more detailed descriptions of the individual criteria, and literature references, have been moved to appendix A for readability reasons.



Organization

The organization criteria are the criteria that will be found to be interesting from the point of view of the management and the sales department. These criteria describe how well the IS support organization's performance (as opposed to how well the technology or a specific individual performs).

The criteria in the organization category are divided into the topics "Performance" (Table I), "Control" (Table II) and "Economy" (Table III).

Individual

The individual criteria relate to the performance and satisfaction of individuals within the information system. The criteria within the individual category are divided into the topics "Emancipation" (Table IV), "Ergonomy" (Table V) and "Communication" (Table VI).

Information

The information category of criteria relate to the quality and access of information. It is divided into the topics "Access" (Table VII), "Quality" (Table VIII) and "Durability" (Table IX).

Technology

The technology criteria are all those criteria that relate to tangible artifacts that participate in distributing and managing information. Sometimes paired with use, this is what most literature will call "information system" or "information technology". The technology category is divided into the topics "Usability" (Table X), "Security" (Table XI), "Software" (Table XII) and "Hardware" (Table XIII).

Systemics

The systemics criteria are related to a systems' point of view of the IS. These criteria study how well the IS conform to what can be said to be a good general system. The systemics category is divided into the topics "Cybernetics" (Table XIV), "Model conformance" (Table XV) and "Systems properties" (Table XVI).

Operationalization, implementation and usage

It is beyond the scope of this article to explicitly define how the criteria can be measured in practice. However, some general guidelines can be provided with the warning that they come from a theoretical discussion, and will most likely be changed in a later stage of the research process.

Formulation and measurement of criteria

The criteria listed in the tables are formulated in a generic manner. In most cases it is not obvious how they will be measured in practice. In future work, it is my intention to operationalize each criterion. To fulfill this, each criterion must in the end fulfill these qualities:

- Measurability
- Explicit definition
- Quantification
- Possible to validate

Measurability: The purpose with all the above is to be able to measure and compare information systems. Thus the criteria themselves will need to be measurable. The mode of the measurement is another discussion, but in the end it must be possible to assign a value to a criterion.

Explicit definition: In order to do so, the criteria must be defined and broken down into points of observation, where it is stated clearly what entity or phenomenon the observation points actually concern.

Quantification: While not strictly necessary, it is my belief that it is a good design goal to formulate the measurements of the points of observation in a quantitative manner.

Possible to validate: With the above three points, it should also be possible to evaluate how well a specific contribute to the overall quality of an information system. Criteria which can be shown to have no impact should be removed.

It is likely that each criterion will be broken down into a number of points of measurement which together will serve as the operationalization for the criterion.

Technological support for evaluation

One of the inspirations of this work has been prior work with simulations of information systems, see for example (Palmius J, 2005a) and (Palmius J, Egonsdotter G, Asproth V 2003). One of the previous problems was the lack of definite operationalizations of key variables for basing the simulation on. In the future, a functional set of criteria should be possible to reformulate into variables

for use in simulations. This is one intended technological implementation of the criteria model.

Another intended implementation is a software for registering and analyzing measurements. The intention is that this should mechanically be able to identify weaknesses based on registered observations of an information system, or a model of an information system.

Design and the temporal space for the evaluation

The criteria for evaluating an information system are formulated from the basis that there is an information system to evaluate. This implies that the evaluation is done post-hoc. However, if there is a good model of an intended information system, the evaluation could also be done pre-hoc.

It is my assumption that when the criteria are used, most of the evaluations in practice will be carried out on models of information systems anyhow, with some validation done through feedback from the participants in the information system.

Since a design of IS is usually conducted through model construction, one immediate use of the criteria list is that it can be used as a checklist during the design of a system. The designer, the customer and the users and compare sketches of the information system with the criteria model to see if there is something obvious missing.

Priority of criteria

The listed criteria are not ordered according to priority or weight. In final usage they must be, so that a person comparing two systems can have a good basis for choosing which criteria to include. Adding this priority now is beyond the scope of the article.

Discussion

The long term goal with the contents of the above article is to provide a basis for a quantitative model, a tool for measuring, comparing and possibly simulating information systems. Obviously, there is a lot left to be done before such a tool can be finished. First and foremost, the theories here presented must be put against empirics.

At this point in time, the set of criteria here are a theoretical construct which has not been tested against practice. This is a common problem with criteria-based models for evaluations of information systems. Even the most tested model, the DMSM, has been criticized for being largely untested empirically more than a decade after its conception (Iivari J, 2005). Still, the empirical tests that have been conducted have indicated usefulness rather than hinting against it.

My extended set of criteria does of course need to be put against an empirical reality. Until this is done, they can at the most be accepted as an inspiration or a list of things to consider when investigating information systems.

One critique which has been raised against the research in this article is that even DMSM is bloated and too large to be practically useful. Thus, writing a list of criteria more than twice as large is the wrong way to go. I can sympathize with this critique. However, in order to build a functional tool, I still feel that the right way to go is through finding all the criteria one can find, and then reduce them. The criteria list presented above is not a finished tool; rather it is intended as a step towards such a tool.

Somewhat related to the previous critique is the comment that to undertake a project to build a model such as this is very, very ambitious. Probably too ambitious. This completely true, and I do not claim that this model could easily be finished. In the following years, what I can address myself will be the model as such, and validation of sections of it. There is no way that I can myself complete this whole model, operationalize it and test it against empirics. I invite other people to join in on the discussion and expand and test the parts of the model they find interesting.

Another valid critique is that no heed has been taken to interdependencies between criteria. A factor analysis of a case scenario would likely show that several criteria really are indicators of the same hidden variable. Again, I sympathize with this critique, and again I will say that it is too early to make such an analysis. Before having done an initial sorting based on empirical results, it would be overkill to gather enough data to do a factor analysis.

Further critique says that no heed has been taken to the fact that the criteria are not equal. They are not equally important, and describe so different things that they, so to say, describe "apples and pears". The first part of this critique I agree with, with the second I do not. It is true that some criteria describe mission critical qualities while others describe peripheral details. I do not claim otherwise. I do however claim that the prioritizing of criteria must be done on a later stage and on a case-by-case basis. The model will eventually have to be amended with a support for how to do conduct such a prioritizing. For the apples-and-pears critique I simply do not agree it is a problem. An information system is a complex thing. The measurements for describing it cannot be expected to be uniform, and it is not desirable that they be.

Finally, it has been asked if this whole discussion cannot be broken down to what was specified as requirements for a system, and whether the end system fulfilled those requirements. This may be so. However, in order to write the specification, one needs criteria for the evaluation of the information system. The specification must come from somewhere: The criteria model comes before the specification.

Summary and conclusions

Several criteria models for evaluating information systems exist today. However, they all share the problem of being focusing at a subset of the information system. Further, most share the problem of having had very little exposure to real-world testing.

By combining criteria from several publicly available sources, it is possible to make a more general and holistic criteria model. These sources may not always have been intended to focus on IS evaluations, but through minor reformulations they can be made to fit.

At this stage, the criteria model exists, but is empirically untested. Further work will have to determine the validity of the respective criteria, and aspects such as criteria interdependencies.

References

- Ashby WR (1962): Principles of the Self-organizing System (from Klir, ed, 1991): Facets of Systems Science New York, USA. Plenum Press.
- Borglund E (2005): Electronic Record Quality, Necessary Inter Alia for Trustworthy E-government Services. In Soliman KS ed. (2005): Proceedings of the 2005 international business information management conference. IBIMA.
- Borglund E, Öberg LM (2006): What are the characteristics of Records? International Journal of Public Information Systems. 2006(1) 55-76.
- Borglund E (2006): A Predictive Model for Attaining Quality in Recordkeeping. Mid Sweden University Licentiate Thesis 12. Härnösand, Sweden.
- Checkland P, Scholes J (1997): Soft systems methodology in action. John Wiley & Sons. Salisbury, UK.
- DeLone W, McLean E (1992): Information Systems Success: The Quest for the Dependent Variable. Information Systems Research. Vol 3, no 1.
- DeLone W, McLean E (2003): The DeLone and McLean Model of Information Systems Success: A Ten-year Update. Journal of Management Information Systems, vol 19, no 4. ME Sharpe Inc.
- Espejo R, Harnden R (1996): The Viable System Model - Interpretations and applications of Stafford Beer's VSM. John Wiley & Sons. Salisbury, UK.
- Finne A (2005): Blueprint for General Quality Attribute Model. Proceedings of IRIS'28.
- Flood R, Carson E (1993): Dealing with complexity - An introduction to the theory and application of systems science. Plenum press. New York, USA.
- Hitt L, Brynjolfsson E (1996): Productivity, business profitability and consumer surplus: Three different measures of information technology value. MIS Quarterly / June 1996.
- Holmberg S (2001): Taking Syntegrity-4 from assumption mode to reflection mode. Systems research and behavioral science. No 18.
- Iivari J (2005): An Empirical Test of the DeLone-McLean Model of Information Systems Success. Advances in Information Systems. Vol 36, no 2.

- Irani Z (2002): Information systems evaluation: navigating through the problem domain. Information & Management. vol 40. Elsevier.
- ISO 9000 (2005): Quality management systems - fundamentals and vocabulary. Third edition. ISO ref nr 9000:2005(E). ISO. Geneva, Switzerland.
- ISO 9126-1 (2003): Software engineering - product quality - part 1: quality model. ISO ref nr ISO/IEC 9126-1:2001(E). SIS Förlag AB. Stockholm, Sweden.
- ISO 9126-2 (2004): Software engineering - product quality - part 2: external metrics. ISO ref nr ISO/IEC TR 9126-2:2003(E). SIS Förlag AB. Stockholm, Sweden.
- ISO 9126-3 (2004): Software engineering - product quality - part 3: internal metrics. ISO ref nr ISO/IEC TR 9126-3:2003(E). SIS Förlag AB. Stockholm, Sweden.
- ISO 9126-4 (2004): Software engineering - product quality - part 4: quality in use metrics. ISO ref nr ISO/IEC TR 9126-4:2004(E). SIS Förlag AB. Stockholm, Sweden.
- IT Library (2007): ITIL Open Guide. <http://www.itlibrary.org> (link visited 2007-03-25).
- Jiang J, Klein G (1999): User evaluation of information systems: By system topology. IEEE transactions on systems, man, and cybernetics - part a: systems and humans. Vol 29. No 1.
- Martinsons M, Davison R, Tse D (1999): The balanced scorecard: A foundation for the strategic management of information systems. Decision Support Systems. Vol 25.
- Miller JG (1978): Living Systems. McGraw-hill. USA.
- Nielsen J (1993): Usability Engineering. Academic Press. San Diego, USA.
- Palmius J, Egonsdotter G, Asproth V (2003): Simulations of highly complex social systems as a tool for designing information systems. From Dubois D, ed (2004): International Journal of Computing Anticipatory Systems. Vol 14.
- Palmius, J (2005a): A theoretical base for the High-level simulation of organisational information systems. Systems Research & Behavioral Science. No 22.
- Palmius, J (2005b): A theoretical base for the simulation of information systems. Mid Sweden University Licentiate Thesis 8. Östersund, Sweden.
- Pitt L, Watson R, Kavan B (1995): Service Quality: A measure of information systems effectiveness. MIS Quarterly / June 1995.
- Rai A, Lang S, Welker R (2002): Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis. Information Systems Research. Vol 13, no 1.
- Rogers P (2007): Meta-evaluation bibliography. <http://www.scu.edu.au/schools/gcm/ar/arp/meta-eval-bib.html>
- Seddon P (1997): A respecification and Extension of the DeLone and McLean Model of IS Success. Information Systems Research. Vol 8, no 3.
- Shannon C (1948): A mathematical model of communication. Bell System Technical Journal, vol. 27, pp. 379-423, 623-656
- Torkzadeh G, Doll W (1999): The development of a tool for measuring the perceived impact of information technology on work. Omega - the international journal of management science. No 27. Pergamon.

Appendix A - Criteria Tables

Organization

Table I: Organization / Performance

Performance	
Transmission	How efficient (as in speed) the information distribution is within the organization
Failrate	How often a failure (lost information, corruption..) occurs
Congestion	How often information heaps up in one place (information overflow, overfeed)
Underfeed	How often segments of the organization has to be idle due to lack of information

Literature: Transmission (Shannon C, 1948), Failrate (Shannon C, 1948), Congestion (Palmius J, 2005), Underfeed (Palmius J, 2005). (note that Shannon used the terms channel and noise, and that the reformulations might not exactly fit the original meaning).

Table II: Organization / Control

Control	
Knowledge mgmt	How well the information is stored in the organization rather than dependent on specific individuals
Overview	How salient the information channels are
Flexibility	How easy it is to modify the system to upcoming needs
Managability	How well the system supports management of the organization (order propagation)
Dec. Speed	How quickly decisions can be taken
Dec. accuracy	How often decisions are wrong or inaccurate

Literature: Flexibility (Irani Z, 2002), Managability (Torkzadeh G, Doll W, 1999), Decision speed (DeLone W, McLean E, 1992), Decision Accuracy (DeLone W, McLean E, 1992)

Not in literature: Knowledge management (rather, I have not picked any specific reference for this, it is a large field), Overview.

Table III: Organization / Economy

Economy	
ROI	Return on investment
Competitiveness	Does the information system make the organization more able to compete with the environment
Cust. satisfaction	Are external customers happy?
Productivity	Does the system support production in a satisfactory fashion?

Literature: ROI (DeLone W, McLean E, 1992), Competitiveness (Irani Z, 2002), customer satisfaction (Torkzadeh G, Doll W, 1999), productivity (Torkzadeh G, Doll W, 1999)

Individual

Table IV: Individual / Emancipation

Emancipation	
Satisfaction	Is the individual satisfied with the information system
Democracy	Can the individual make his voice heard publicly
Influence	Can the individual influence his own situation through the system
Learning	Is the individual given the opportunity to develop skills and understanding through the system

Literature: Learning (DeLone W, McLean E, 1992)

Not in literature: Satisfaction, democracy, influence

Table V: Individual / Ergonomy

Ergonomy	
Stress	Does the IS contribute to stressing the individual (for example through being difficult to manage)
Overload	How often does the IS provide too much information
Underfeed	How often does the IS provide too little information
Control	Can the individual configure his role and the technology in the IS to fit his own needs

Literature: Overload (Palmius J, 2005b), Underfeed (Palmius J, 2005b)

Not in literature: Stress, control

Table VI: Individual / Communication

Communication	
Informedness	Is the individual informed about the things he needs to know about in the organization
Social interaction	Does the IS provide support for the individual's need for interacting with other people
Social belonging	Does the IS support a sense of belonging

Literature: informedness (DeLone W, McLean E, 1992)

Not in literature: social interaction, social belonging

Information

Table VII: Information / Access

Access	
Accessibility	Is the information within the IS easy to reach?
Searchability	Is it easy to find a specific desired piece of information?
Format	Is the information within the IS available in an appropriate format

Literature: Accessibility (Borglund E, 2005), Searchability (Borglund E, 2005), format (DeLone W, McLean E, 1992)

Table VIII: Information / Quality

Quality	
Accuracy	How accurate is the information within the IS
Relevance	How relevant is the information within the IS
Importance	How important is the information within the IS
Reliability	How reliable (repeatable, stable) is the information within the IS
Uniqueness	How often does redundant information flow in the IS
Free from bias	How objective is the information (ie, how often has it passed through interpretations)

Literature: accuracy (DeLone W, McLean E, 1992), Relevance (DeLone W, McLean E, 1992), Importance (DeLone W, McLean E, 1992), Reliability (DeLone W, McLean E, 1992), uniqueness (DeLone W, McLean E, 1992), free from bias (DeLone W, McLean E, 1992)

Table IX: Information / Durability

Durability	
Archivability	How well information in the IS is fit to be stored in an archive
Movability	How easy it is to move archived information
Portability	How easy it is to transfer archived information to another system
Traceability	How well the archived information supports tracing its origins and context
Original look	How close to the original look the archived information has (ie was it changed significantly when archived?)
Evidence	How well does the archived information support proving that something has happened

Literature: Archivability (Borglund E, 2005), Archivability (Borglund E, 2005), Movability (Borglund E, 2005), Portability (Borglund E, 2005), Traceability (Borglund E, 2005), Original look (Borglund E, 2005), Evidence (Borglund E, Öberg LM, 2006).

Technology

Table X: Technology / Usability

Usability	
Learnability	How easy is it for a new user to understand how to act in the system
Memorability	How easy is it for an experienced user to remember how to act in the system
Efficiency	How much energy does a user need to put into the system to produce a desired result
Effectiveness	How well does the system support solving the problems of a user
Errorproneness	How often does confusion within the system cause user error

Literature: Learnability (Nielsen J, 1993), Memorability (Nielsen J, 1993), Efficiency (Nielsen J, 1993), Effectiveness (Nielsen J, 1993), Errorproneness (Nielsen J, 1993)

Table XI: Technology / Security

Security	
Stability	How stable is the system in the sense of in what rate it breaks down and becomes inaccessible or loses data
Validity	To what extend does the system ensure that information within it is correct (for example not tampered with)
Secrecy	How well does the system protect information from being seen by outsiders

Literature: Stability (Irani Z, 2002), validity (Finne A, 2005)

Not in literature: Secrecy

Table XII: Technology / Software

Software	
Compatibility	How easy it is to move information between different parts of the system
Saliency	How easy it is to understand the software structure (for an administrator)
Availability	How easy it is to acquire the software (and its upgrades)
Replacability	How easy it is to replace parts of the system with new parts (for example other software products)
Licensing	To what extent licensing issues hinders the administrator from doing what he wants with the system
Administration	How easy it is for an administrator to manage the system

Literature: Compatibility (Finne A, 2005), replacability (Finne A, 2005)

Not in literature: Saliency, availability, licensing, administration

Table XIII: Technology / Hardware

Hardware	
Scalability	How well the hardware can be thought to support future needs
Administration	How easy it is to manage the hardware
Performance	How well the hardware supports the current needs of the system

Not in literature: Scalability, administration, performance

Systemics

Table XIV: Systemics / Cybernetics

Cybernetics	
Filters	How well divisions between parts of the IS works (forwards relevant information and only that)
Sensors	How well the IS is able to collect information about itself and the environment
Amplifiers	How well parts of the IS is able to stress important information so it gets noted
Feedback	How easy it is to see the effect of an output so that further output can be adjusted.
Viability	How well the IS supports the survival of the host system
Requisite variety	How well the IS is able to manage incoming inputs from the host system and the environment.

Literature: Filters (Flood R, Carson E, 1993), sensors (Flood R, Carson E, 1993), amplifiers (Flood R, Carson E, 1993), feedback (Flood R, Carson E, 1993), viability (Flood R, Carson E, 1993), requisite variety (Flood R, Carson E, 1993)

Table XV: Systemics / Model conformance

Performance	
VSM	How well does the IS fit the idea of how VSM thinks a system should look
Living systems	How well does the IS fit the idea of how living systems thinks a system should look
SSM	How well does the IS fit the idea of how SSM thinks a system should look
ITIL	How well does the IS fit the idea of how ITIL thinks a system should look

Literature: VSM (Espejo R, Harnden R, 1996), Living Systems (Miller JG, 1978), SSM (Checkland P, Scholes J, 1997), ITIL (IT Library, 2007)

Table XVI: Systems / System properties

Systems prop.	
Efficacy	Does the IS actually solve the problem it was intended to solve
Cult. Feasibility	Does the current setup of the IS fit how persons in the organization think how things should be
Syst. Desirability	From an expert point of view, is the system constructed in what is usually thought a good manner?

Literature: Cultural feasibility (Checkland P, Scholes J, 1997), systemic desirability (Checkland P, Scholes J, 1997)

Not in literature: efficacy

Measuring The Effects of SOA on Business – Description of The Study

Annika Granebring

Lic, School of Economics, Mälardalen University, Sweden

annika.granebring@mdh.se

Cecilia Lindh

PhD, School of Economics, Mälardalen University, Sweden

cecila.lindh@mdh.se

Abstract. In Sweden, a forerunner in the field of adopting Service-oriented Architecture (SOA), the private and the public sector both are filling posts of different architect roles. This paper presents the structure of an ongoing quantitative study exploring how certified architects practicing as in-house architects or as consultants influence the adoption of SOA in Sweden. The aim of this quantitative study is to describe how certified architects influence enterprises' awareness and practice of SOA in Sweden. A questionnaire was created based on the effects of the certification on the individual, on the employer, and on business. The questionnaire was distributed to the whole population of the 259 professionals who were certified during the period of 2003--2006. This certification program of solution architects, so far is the only available way to certify IT architects in Sweden, is now closed. The initial findings of the study suggest that certified architects are important to consider when tracking the adoption of SOA in Sweden. Certified architects play an important change-agent role in the organizations where they design, develop and implement composite applications with a new way of thinking.

Keywords. SOA, business value, Swedish official architect certification, adoption, Innovation Diffusion Theory.

Introduction

At an architecture seminar “Web Service Factory and the future system architecture” in Stockholm 2007-03-07 it was proclaimed that the three upheavals in our modern society called the information and knowledge age are service-oriented architecture (SOA), the semantic web (web 2.0), and software-as-a-service (SaaS). Trying to explain what these three phenonemas are for people that have never heard of them is not simple especially since they have common parts and seem to convergence (Holding, 2007). We will start to explain what

SOA is according to own experience. Having in mind that SOA is more about consuming services than building services (Mullender, 2005) the following is needed to build SOA software. First you need to invest in expensive infrastructure like an open communication platform with an development environment. Then a good idea is to adopt a architectural framework, i.e. a best-practice with examples for how to build services, how to document and monitor the SOA work-in-progress (van den Berg & van Steenberg, 2006, Granebring et al., 2007b). Finally you need resources (architects and developers) and time. SOA follows a maturity process and it will take at least five years to become a somewhat succesful builder of SOA software (Granebring et al., 2007c). To make SOA understandable figure 1 is sketching a real life practical example when describing SOA. The case company has built a gift certificates (GC) system based on SOA principles (see figure 1).

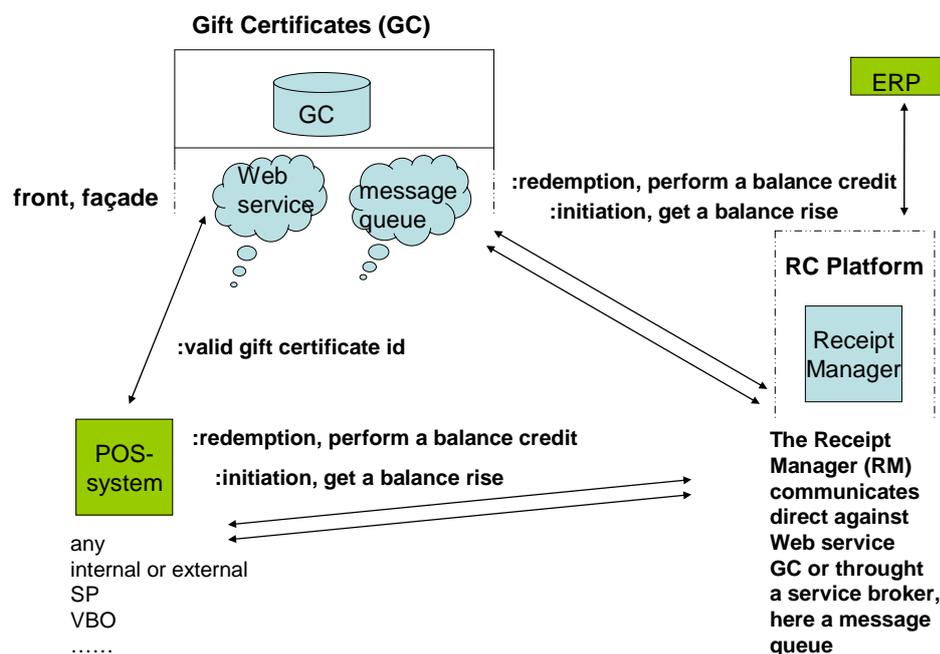


Figure 1. Schematic view of an SOA application

This GC service is designed as a “black box” and can be implemented in any country, in any environment, and can communicate with any external systems like a computerized cashier systems and ERP systems. GC contains a entity service; e.g. gift certificates with drawers and redemptions, business rules (valid until, clearing rules) and process services containing activity services (register, fill, use, clearing between stores). There are two ways for the outside world to communicate with the GC. One way is through the web service with polite requests like; what is the value of the GC, is the the GC valid, make a new GC. The other way is through a service broker, in this case a message queue (see figure 1). This message queue, receiving all receipts, separates those receipts that have lines with purchases concerning filling amount to GC or receipts that use GC as payment. The message queue is managed message by message in a secure way. The Receipt Manager (RM) is an activity service that is included in the Retail Center Platform. This communication platform Retail Center manages communication with any ERP system. An example of a global web service is when the cashier in a shop gets discount coupons or value checks as payments and these are cleared at run-time by a web service located somewhere unknown. The point-of-sale store system only have to know how to ask to get the answer back if the discount coupons and value checks are

passed or not. Coupon management is a global service available by Coupon Redemption (Kuponginlösen AB) and offered on the market to all stores. The semantic web (web 2.0), i.e. blogs¹, wikis, web services, pod radio, and social networks, is designed for and by interactivity. The “web 2”, a meta-web built on the existing WWW to facilitate its access, might change the way some businesses interact with their customers and also the way they organize their internal work (Sundblad & Sundblad, 2007). According to Michael Wesch, assistant professor of cultural anthropology at Kansas state university, the web 2.0 forces the rethinking of concepts as authorship, privacy, governance, family, copyright, love, ethics, identity, rhetoric, commerce and ourselves (see Welsch’s film in the references). The connection between web 2.0 and SOA concepts are blurred. Both concepts deal with best practices for building business processes into supply chains. In contrast to web 2.0, SOA has the concept of orchestration. Web 2.0 embraces people, collaboration, architectures of participation, social mechanisms, real-time feedback, etc. SOA is the structured corporate world and web 2.0 is global and deals with unstructured sources. In order to convergence the semantic web 2.0 gets more service oriented, whereas the SOA need to get more consumer oriented and lightweight. Software as a service (SaaS) is web-based applications managed from the vendor’s server that do not have to be installed or updated on the customers’ computers (Langedijk, 2006). To manage integration of multiple SaaS services in one open platform XML and OSS are basic conditions. Not having to own the software is a low-cost and convenient way for customers to use the software (Lager 2006, Langedijk 2006). As with outsourcing, SaaS customers should analyse the contracts with issue like performance, security and must trust confidential data to the premises of the (certified?) supplier (Holding 2007, Orr 2006). Combining these upheavals promises to link not only information but people and have the potential to improve business processes by sharing, trading and collaboration. The foundation of all three of these proposed upheavals is facilitating automated data exchange by separating content and form. The OASIS (the Organization for the Advancement of Structured Information Standards) group defines SOA as the following: “A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations.” In the normative literature, SOA is often characterized as an architectural style on a low abstraction level between software agents that supports loosely coupled networked services to enable flexibility and interoperability, in a technology independent manner (Jacobson et al. 1997, van der Berg et al. 2002). In this study and defined in the questionnaire the researchers (the authors of this article) follow Sundblad’s SOA definition “process oriented development under service oriented architecture, with consideration to how the specific organization views things”. The participating architects in this study are all familiar with this definition from the education program. A research study from the Royal Institute of technology (Lindström et al., 2006) has investigated what SOA can do. A total number of 62 CIOs took part in the investigation comparing the surveyed CIOs’ and the enterprise architecture frameworks’ different prioritization. Architectural Frameworks emphasizes 1) modifiability, e.g. by improving interfaces, introducing open platforms and standard 2) improve the quality of existing services or products that the business organization provides to the customers 3) develop new services or products that the business organization provides to the customers. The CIOs most important concerns are 1) to decrease the cost related to the business organization 2) improve the quality of the interplay between the IT organization and the business organization, such as help desk, end-user training, provide new computer-aided support to the business organization 3) provide new IT based solutions to the IT organization,

1 Architect blogs = Sten and Per Sundblad and at least three of the participating architects in the study blog on the internet (see electronic sources).

such as administrative tools, b-logs, and back-up tools 4) improve the quality of operation and maintenance, development, and acquisition of IT systems. The comparison reveals a potential for harmonization between Enterprise Architecture and the concerns of the CIO. (Lindström et al., 2006). Arsanjani (2002) describes the evolution of the notion of the object paradigm: an object having identity, state and behaviour vs. a component exposing services, contracts, and is configurable without requiring intrusive changes for using it. Modularization and separation of concerns (for example, interface from implementation) are key elements of the SOA paradigm (Arsanjani 2002). Other researchers discuss SOAs implementation or lessons learned from a specific company's process of adopting SOA (of studies at Lund university LTH, Dietrich et al 2007, Wong-Bushby et al., 2006). There is, however, a shortcoming in literature regarding the general effects of SOA on business. An investigation which quantitatively measures the effects and gains (or losses) by SOA could contribute with knowledge on the general outcome of "business improvement through better architected software" as Sundblad & Sundblad (2007) express the goal with SOA. The use of enterprise architecture by companies, in their business activities as well as in other activities, is increasingly becoming a matter of managing "the bigger picture"; e.g. how things are done and the more challenging what the business is capable of (Granebring and Révay 2007). Business improvement is about more than understanding how information flows span over one type of activity – the connection between activities is just as important. Hence, adopting the service-oriented architecture (SOA) approach for their IT systems is becoming increasingly important for enterprises (consultancy firms and users organizations both). If SOA provide business value then the demand for architects practicing SOA is obvious. SOA is such a step change in the way organizations operate that the advantages can be significant. The benefits of a successful deployment of SOA may have a dramatic impact on the contribution ICT makes to the business.

Problem background

Research emphasizes the gap between IT and business (Grudin 1991) and advocates a new discipline of software design driven by business processes, as distinct from software engineering with database focus, is needed (Hevner 2004, Winograd 1996, 2006, Wong-Bushby 2006, Johannesson et al. 2006). The increasing integration complexity (Kelley 2005) of systems and the request for business agility in systems imply the demand for architecture and certified architects (Jacobsson et al. 2007). Sundblad and Sundblad (2007b) recommend a sharp border between architecture and engineering. New generations of software are being developed, which need appropriate methods of analysis and design (e.g. web-based systems and ubiquitous computing), new systems development methods have emerged, which need empirical study and evaluation (e.g. agile methods). Companies are involved in a variety of activities in order to perform business with different counterparts. These activities involve not only the buying and selling or establishment of business relationships with counterparts; there is vast organizing within and between IT solution providers and consultancy firms to secure output and perform business. IT is widely regarded as an enabler of organizational change (Hammer and Champy, 1993). It is argued that the effective use of SOA can provide business value (Biberstein et al. 2006, Jacobson et al. 1997, Watson et al. 2000). Patrik Löwendahl's blog article "Why is SOA broken" criticizes that the waterfalls approach with design first (a Grand Master Plan) gives a false sense of control. Löwendahl suggests the division of SOA into two disciplines; the business model and information analysis part and the scenario based iterative agile service oriented development with dated contracts first. The design of infrastructure architecture artifacts are now on the curriculums as education program at Swedish universities (högskolan i Dalarna HDA-H23YP, högskolan i Borås HB-72320) with

focus in the mainstream data logical track. A certification is not an education. It is a quality mark that a person has a certain level of competence. To take the certification the person must comply with certain requirements like 60 month of experience in project leading in the last ten years, have taken certain courses etc. After passing a test (in writing or interviews) the quality level is reached and the person is certified. The roles and the responsibilities of the architects have not yet been crystallized. The Swedish section of IASA's vision for the career as an architect contents; well-defined roles and knowledge; architects controls the profession themselves; the profession is educational and testable; certification is possible and not controlled by vendors.

Aim

What is SOA, how does it work in practice, what does research say about advantages and disadvantages, how does the architect fit into this picture, is there any research shortcomings, why have we conducted our study, what methods did we use, how did we operationalize the questionnaire and why did we do it like this, what are the findings, and what do they mean to research and practice? This article discusses our investigation on the effects of certified SOA architects performing as enterprise architects, business architects and solution architects in Sweden. Would efficient and effective use of SOA by hiring, or employing certified architects mean that there are positive effects on the output of companies as their business relationships, productivity, efficiency or profit? Does the individual architect benefit from being certified?

Research Method

The investigation comprises 259 respondents from 140 companies. By asking 70 questions to the 259 certified architects, information has been gathered systematically to measure the effects of SOA in a number of areas. The first step in re-inventing the questionnaire was to use prior research done by one of the authors of this article. The design of the questionnaire is sourced from Cecilia Lindh's study (2006). Since it originally is a standard questionnaire the scales are pre validated. Lindh's study (2006), distributed among CEOs and marketing directors, focuses on business relationship, trust and adaption in IT solutions. In this study the respondents are certified architects and the focus is on what kind of business value SOA may give and why. The diffusion of innovation theory was tested amongst certified architects (own, hired or internal consultants) to measure the degree of SOA adoption among Swedish enterprises. Before distribution, the pre-version of the questionnaire was sent to nine "test pilots". Five architects answered and commented the preliminary questionnaire, and two of them were later personally interviewed. Realizing that this category of respondents can not be expected to spend more than an hour on answering the questionnaire the amount questions were limited to 70 questions (from originally over 100 questions). The first section of the questionnaire (questions 1—13) collects information about the company where the architect is employed. The questionnaire was offered both on line and in paper copies. It mainly consists of a seven point Likert scale (Likert, 1932) ranging from overall negative to overall positive. It is rare in qualitative studies that the total population is known. This is the case in this study which increases the quality of the study. The statements measuring the core constructs are in attachment B. The total population is all the 259 professionals having taken all four architect courses and became certified solution architects by Sten Sundblad and Per Sundblad and Microsoft Sweden at the S&S's premises at Kungsgatan in Uppsala between 2003--2006. The data was collected within a time frame of four months from 130 participating architects. First the deadline was set to the 1 January 2007, then the deadline was the postponed to the 1 February, and finally to the 1 Mai to increase the answering frequency. The questionnaire

contains 70 questions (125 with sub-questions and formality questions). Only the company name where the architect worked at the time of their certification was known to the researchers. The architect's names are published at Microsoft's Hall of Fame architect web and on Sundblad & Sundblad's web.

- In December 2006 there was an initial, common presentation of this study and a call at 2XSundblad's private community² for certified architects for the architects to participate by filling up the questionnaire.
- The re-designed questionnaire attached with a letter-of-intent was then sent to the architect's working place email addresses. Some consultancy firms made acquisitions (Atos Origin and Columna by WM-data, Meteorit by Sigma). The Norwegian product company Visma made the acquisition of the product company RBS. Some merge like Aerotech Telub and Combitech Systems. The Swedish government has decided to close down Arbetsmiljöverket. The consultancy Addea is recreated into Kaskelot Consulting. Twenty respondents decline participation due to lack of time, not working with SOA, or just not interested to participate. Twenty architects were not possible to reach and fifty did not reply.
- The next step was to send the questionnaires by "snail-mail" to the companies. "Snail mail" is uncommon nowadays and letters may be left without notice for a long time, especially among consultants spending months and years at customer's sites.
- Then the questionnaire with the letter to follow was sent to the respondent's home address, made known by searching the eniro.se homepage.
- Thirty architects were interviewed by phone.

First the results were coded in an excel sheet, and later transferred into the SPSS application. Regarding the claim that the number of the research population (259) is known this do not mean that there are no foreign SOA certified architects are working in Sweden. Some of the S&S certified architects in the study are working abroad. We ensure anonymity for the firms and not mention them by names as findings may be tied to the few respondents representing each firm. We have operationalized the questionnaire according to Rogers' perceived attributes of innovations. We have not conducted factor analysis and discriminant validity analysis.

Diffusion of innovations

According to Rogers (2003) innovation of diffusion theory is a communication research. Moore and Bensat (1991) stress the lack of instrumentation and have developed characteristics of innovation; relative advantages, compability, complexity, trialability, and observability.

Following questions are formal questions and not operationalised on theory: 1—13, 32—47, 49, 55, 62—70. The variables determining the rate of adoption in organizations are summarized in table 1.

² Private community = closed specific web community designed and administered by S&S and supported by Microsoft. This is a type of network is called "extra-network", managed by a company and suitable for R&D activities. In this kind of "extra-network" can activities like knowledge harvesting and creation occur (Carlsson 2003).

Table 1. Definitions of core concepts in Innovation Diffusion Theory according to Moore & Benbasat (Venkatesh et al, 2003).

Perceived attributes of innovations	Definition	Statement
Relative advantage	“the degree to which an innovation is perceived as being better than its precursor” (Moore & Benbasat, 1991, p. 195).	14 15 16 18 19 21 23 24 28 60
Compability	“the degree to which an innovation is perceived as being consistent with existing values, needs, and past experiences of potential adopters” (Moore & Benbasat, 1991, p. 195)	20 22 29 31 50 51 57 61
Complexity	“the degree to which an innovation is perceived as being difficult to use” (Moore & Benbasat, 1991, p. 195).	25 26 27 30 52 53 54-56
Trialability	“the degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system” (Moore & Benbasat, 1991, p. 195).	58
Observability	“the tangibility of the results using the innovation, including their observability and communicability” (Moore & Benbasat, 1991, p. 203).	17 22 48
Drawbacks & Obstacles		

Diffusion is defined as a process, changing a social system and leading to certain consequences. The innovation process in organisations consist of two broad activities: (I) initiation, defined as the entire information gathering, conceptualizing and planning for the adoption of an innovation, and (II) implementation, all of the events, actions and decisions involved in putting an innovation into use. Initiation is divided into two stages, I-1 agenda-setting and I-2 matching, while implementation comprises the three stages of II-1 redefining/restructuring, II-2 clarifying, and II-3 routinizing. Agenda-setting occurs in the innovation process when a general organisational problem that may create a need for an innovation is defined. During this stage a performance gap, a discrepancy between an organisations expectations and actual performance, is defined. During the matching stage the innovation is tailored to solve the organisational problem and hence fill the performance gap. The first stage of the implementation is redefining/restructuring, when the innovation is re-invented to accommodate the organisational needs more closely. Clarifying occurs as the innovation is put to a more widespread use and the meaning of the innovation becomes clear to the organisation’s members. Routinizing marks the end of the innovation process, as the innovation becomes an incorporated part of the organisation and ceases to be an innovation.

Who are participating in the study

The known total population of this study (published at the Hall of Fame Microsoft .NET-architects) contains 259 certified architects that are experienced, have academic education, work in knowledge intensive firms, and are often taking on specialist or managerial roles. The total population consists of 15 female architects (5 %) and 244 men (95 %). 20 of the architects are from the public sector (8 %) such as Kriminalvården, Karolinska sjukhuset,

Sjöfartsverket, Mälardalen University, Vägverket, Tullen, AMS, AV, Energimyndigheten, Swedish Standards Institute (SIS), and wholly owned companies by the Swedish State like Svenska Spel, and companies part owned by the Swedish State like TeliaSonera, LKAB, and SSAB. In 2003 17 architects were certified, in 2004 63, in 2005 88, and in 2006 91 architects were certified – a steady increase. The distribution of the architects according to organizational belonging is (question 8):

1. The largest Swedish IT consultancies, mid-sized and small IT consultancy agencies.
2. Large enterprises (private or public), e.g. users of SOA architects working in own organizations as internal consultants in government-owned agencies, retailers, large banks and insurance companies.
3. Product companies.

2/3 of the architects are from the consultancy part (category 1 – q. 8) and 1/3 of the architects are from the user side (category 2). To be an architect in a “user organization” might imply a special difficulty. The architect should represent the end-users. This can be hard to represent the customers against the employer. Approximately 10 % of the respondents are from product companies.

Swedish architectural certification programs

Dataföreningen and Jönsson & Lepp have similar architectural educations, based on SOA (Service-Oriented Architecture), resulting in a diploma not a certification. There are corresponding programs and certification for the JAVA platform. The Sundblad & Sundblad’s Swedish architect program is the only one - for now – that offer a certification. The S&S curriculum consists of four three-day courses; Patterns for Architecture and Design; Software Architecture and Architecture Roles; Vision, Information and Requirement Analysis; and Design of Service-Oriented Solutions. These teacher-led four courses were conducted iteratively through a series of occasions in S&S’s premises in Uppsala between 2003 and 2006. 10—30 persons have participated in each course. The total S&S education program (12 days) including certification cost 420000 US\$ (60000 SEK) plus taxes. S&S and Microsoft Sweden have certified 259 professionals as .NET³ architects in the program. A large proportion of them coming from high-prestige international companies. Large IT vendors sent their consultants to Uppsala to be certified architects.

In December 2006 S&S closed this teacher-led national architect program. Microsoft Learning acquired a license from S&S to use their curriculum for a global online architecture training and certification program. An enhanced curriculum and its individual courses will be offered to a global community in an online format. Microsoft Learning agreed to “grandfather” each architect trained and certified by S&S also into Microsoft’s global architect program.

Results

In this article some initial findings are presented, covering areas such as:

3 Microsoft’s Visual Studio .NET is a development and implementation environment based on the strategy of openness and to deliver software as services (Reynolds et al. 2001). The framework integrates COM+ and Active Server Pages (ASP) built around XML/SOAP. The studio includes VB, C# (C-sharp), Visual C++, web forms, XML facilities, and Web services.

- Sweden is a country with many various ERP systems needed to be integrated (question 55).⁴
- The respondents of this study operate in different industries (q. 13); retail(17 respondents), energy(2), manufacturing industry(35), travels(5), healthcare(8), banking-insurance-brokers(39), telecom(3), the public sector(7), shipping(1), real estate(3), distribution of business information, e.g. document automation(6), transportation(1), online-games(2), defense industry(2), software development(3), union trade(1), geo technology(1).

White papers and research recommend a step by step approach with SOA. This piece of advice is followed by the architect respondents in this study. Business systems have been architected and built around S&S's ideas (Ikanobanken, RBS, and Systemteknik). Question 12: "Which open communication platform are you mainly working on?" Most respondents answer MS and MS is part of the certification. Many architects comment that SOA is platform independent. Knowing both JAVA and MS developing environments is an advantage. There are also other development environments like mainframe and the development environment for JAS 39 Gripen. Question 20: "In the future I believe I will work more with SOA". Here there is consensus and the answers span between 5 and 7 on the Likert scale (many answer 7 = I agree completely). Question 29 "For how many years have the firm/organization practiced SOA of some kind?" The diffusion varies from 0 to 8 years. Answers on question 35 suggest that the relation between the customer and the consultant is more sustainable than the relationship between the consultant and the employer. Question 36 is an example of the tricky business of asking questions. Many architects write that every customer is equally important. This is of course altruistic true and not presenting the plain percentage we had expected. Many architects remark that the questions are a bit in the middle not suitable for consultants nor employees at an enterprise. Other criticism is that several questions are dealing with the same issues. The specific SOA solution need to be adjusted to the size of the application and how business critical the application is. Architects from product companies express that knowledge about the industry/business is more important than the ICT knowledge. The customers talk the business language not the language of ICT. Many respondents express that the main benefit from the education is that they started to "think SOA" and this made them as individuals gain greater influence over developments in the organization. Being a certified architect has meant better opportunities, new tasks and better salary for mainly those architects that have moved on to a new employer and taking on a specialist architect role. Twenty architects have got new posts since the certification.

Analysis

This analysis is descriptive. SOA in the insurance, healthcare and sector is increasing according to results in our study. Many architects express taking on an opinion leadership role (Rogers p. 27) in their organization after the certification. Many of the consultants (question 8: category 1) have their customers in companies from category 2 (users) and category 3 (product companies). Microsoft's partner philosophy helps their cooperative partners (like Kentor, CAP, KnowIT etc.) do better SOA and also supports product companies to develop

4 Agresso, Aspect/4, ASW, Axapta, Briljant, BPCS (AS/400), ByggGt, Economa, Garp, Hogia MobiLast, IDMS (main frame), Jeeves, JD Edwards, Kassanova, Movex, SAP, RainDance (WM-data's finance system), , SoftOneBusiness, Trygg2000, iScala (Wintel), customized AS400 solutions, STYR/400 is a general, standard packet for IBM iSeries (AS/400), Oracle OneWorld, Pengvin, Peoplesoft, Pyramid/4, Visma (Business, XOR Control, spcf),

better SOA by Visual Studio. SOA is a large vision to put on and the respondents express that their company or their customer do not apply SOA in practice. Rather they feel that companies are starting to think SOA and wanting to do SOA. Many internal projects investigate the possibility of introducing architecture for government but have not yet implemented any solutions (H&M, Scania, Westinghouse, Readsoft, Wide International, AV, Pdb, and AMS). Architects being certified in the beginning of the period present a more troublesome journey than those certified in 2006. Lately the doors have opened for SOA and the principal guidelines of SOA are generally accepted. This is an observation also made by Per and Sten Sundblad. In the courses currently appearing "bee hives" where SOA issues are discussed there are more of consensus than a few years ago.

There are several examples of SOA solutions from the study (question 32-34) that supports the business processes by local IT solutions on a global, standardized foundation over geographical limits. Managing bonuses on European and local level, ordering patient transports by nurses' sms-ing to janitors in Norway are examples from this study. There is a demand for mentorship between the architects. We have found that there are requests and exchanging of knowledge and jobs going on between architects. The organizing around the enterprise architecture enables rewarding meetings between the business' side and the developer's side. When the acquirer, the business manager, project leader, different architect roles from both sides contribute and take the time to cooperate and discuss the business problems, the different solutions, and the potential business improvement this is a great progress from just discussing the time of delivery and performance.

Attributes	
Relative advantages i.e. does certification training deliver value for 1. the individual, 2. the employer, and business.	<p>1. Effects for the individual (question 14, 15, 18, 19, and 23).</p> <p>Better salary (q 24). Just in a few cases but taking an architect role in another organization often imply better salary.</p> <p>2. Improved service quality, support and more satisfied customers.</p> <p>Improved productivity and motivation (question 31).</p> <p>Increased credibility and ability to solve problems (question 18, 23).</p> <p>Improved finances by more effective enterprise and by using resources well (question 16, 17, 21, 24, 28, and 56).</p>
Compatibility, i.e. consistency with existing systems & needs? Easy to change; easy to move information between systems.	<ul style="list-style-type: none"> ▪ Usage of SOA now and in the future (question 20, 29) ▪ Architectural knowledge gained through the courses and make use of the net work of certified architects (question 22). ▪ Effects of SOA in practice (question 31, 57) – no isolated information islands & step by step approach.
Complexity is reduced by the universal abstraction of SOA	<ul style="list-style-type: none"> ▪ Usage of SOA in another domain (25, 52). ▪ Same SOA used in different business experiences (26, 27, and 30).
Trialability	Interaction and mentorship in the network of certified architects.
Observability, e.g. improve accountability and transparency.	<ul style="list-style-type: none"> ▪ The company and the individual benefits from the improved reputation. (q 17). Consultancies in their marketing (web sites & CV) announce having certified architects in their staff in their marketing on web sites and CVs. <p>Content in the certification program (q. 22) where an important issue is how to communicate the requirements to business (using the language of the business and visualization) and the design to developers.</p>
Drawbacks & Obstacles	

Table 2: Rogers' diffusion theory is operationalized on whether architect certification deliver value to the individual, the employer, and to the business. Innovation is here defines as developing software with trained certified IT architects vs. developing SOA without own or hired certified architects. Source: questions and data from the questionnaire operationalized on Rogers' Diffusion of Innovation Theory [13 p. 207].

Conclusions and future research

Although 50 % falling off (130 participating respondents out of 259) we with some trustworthiness conclude the facilitation of ICT by enterprise architecture but it is not easy to accomplish and establish this enterprise architecture. Hiring or employing certified architects

with skills and experience is one action being taken. The certified architects from the specific certification program in this study (and other similar education programs) go back and forth in and out of enterprises and consultancy agencies; forging relationships. This common reference base from the education programs and the experience from different SOA practices ease the adoption of SOA. The systems will be even more open, rich and complex in the future, making SOA and software architects even more sought after. There are benefits by the certification for employer and the individual architect both:

- More effective enterprise and decreasing costs. (question 56)
- Improved customer dialogue, development adjusted to respond to changing customer requirement increase software quality make customers more satisfied. (questions 69, 70)
- Improved productivity and motivation. (questions 31, 21)
- The individual architect benefits from the improved reputation (q. 23, 24)
- The whole company benefits from the improved reputation. (16, 17)
- Increased credibility and ability to solve problems. (23, 26, 28)
- More joy of work by higher competence. (15, 19, 20)
- Make use of the architectural knowledge and the net works of certified architects. (22)
- Both the knowledge collected in the courses and experiences and best practices are exchanged are valuable.

Enterprise Architecture is a young discipline and the enterprise architect role is maturing. Demand is high in the Internet and network areas of e-commerce, communication, object programming, data security, and data warehousing as enterprises try to prepare for the next wave of the new wireless technology. The internet is growing in importance, not only as a distribution channel but also as basic technology for the automation of business processes between business partners. The next article will present initial results from this study trying to measure the effects of SOA on business.

References

- Arsanjani, A. (2002) "Developing and Integrating Enterprise Components and Services". *Communications of the ACM*, 45(10), 31-34.
- Biberstein, N., Bose, S., Fiammante, M., Jones, K. and Shah, R. (2006). *Service-Oriented Architecture Compass*, IBM Press.
- Carlsson, S. (2003). "Knowledge Managing and Knowledge Management in Systems in Inter-Organizational Networks", *Knowledge and Process Management*, 10(3), 194-206.
- Christiansson, M-T. and Christiansson, B. (2006). *Mötet mellan process och komponent – mot ett ramverk för verksamhetsnära kravspecifikation vid anskaffning av komponentbaserade informationssystem*. doctoral dissertation, Linköping University.
- Dietrich, A., Kirn, S, and Sugumaran, V. (2007). "A Service-Oriented Architecture for Mass Customization—A Shoe Industry Case Study", *IEEE Transactions on Engineering Management*, 54(1).
- Fensel, D., Hendler, J. Lieberman, H., and Wahlster, W. (2003). *Spinning the Semantic Web*. MIT Press,
- Fowler, M. (2003). "Who needs an Architect?", *IEEE Software*, 20(5). 11-13.
- Goethals, F., Lemahieu, W., Snoeck, M. and Vandenbulcke, J. (2007). "The data building blocks of the enterprise architect", *Future Generation Computer Systems*, 23, 269–274.

- Granebring, A. (2007). "SOA for retail enterprise systems – a case study at one retail software company in Sweden", submitted to *International Journal of public information systems* (IJPIS website www.ijpis.net), Bo Sundgren.
- Granebring, A. and Révay, P. (2007a). "SOA is a driver for daily decision support", *Kybernetes: International Journal of Systems & Cybernetics, Business and Management Science, Emerald*, 36(5/6).
- Granebring, A. and Révay, P. (2007b). *Enterprise Architecture framework in practice*. Paper presented at the 2007 MicroCAD International Conference, Miskolc, Hungary.
- Granebring, A. and Révay, P. (2007c). *Maturity stages in SOA*. Paper presented at the 2007 MicroCAD International Conference, Miskolc, Hungary.
- Granebring, A. and Révay, P. (2006a). *Creating sustainable retail solutions with SOA*. Paper presented at the 2006 MicroCAD International Conference, Miskolc, Hungary.
- Granebring, A., Thilénus, P. and Révay, P. (2006b). *SOA is a driver for personalization*. Paper presented at the 2006 European Conference on Information Management and Evaluation (ECITE-06), Genua, Italy.
- Grudin, J. (1991). "Interactive Systems: Bridging the Gaps between Developers and Users", *IEEE Computer*, 24(4), 245-264.
- Hammer, M. and Champy, J. (1993) *Re-engineering the Corporation*, New York Harper Business.
- Havenstein, H. (2006). "New Job Functions Emerge With SOAs", *Computerworld*, 40(17), 12.
- Hevner, A. (2004). "Design Science in Information Systems Research", *MIS Quarterly*, 28(1), 75-105.
- Houlding, D. (2007). "From SOA to SaaS", *The World of Software Development*, 32(4), 32-37.
- Jacobson, I., Griss, M. and Jonsson, P. (1997). *Software Reuse Architecture, Process and Organization for Business Success*. Addison Wesley Longman, Inc., California, Menio Park.
- Johannesson, P., Perjons, E., Wangler, B. and Åhlfeldt, M-L. (2006). Interoperability of Enterprise Software and Applications, book chapter in *Design Solutions for Interoperability using a Process Manager*, Springer.
- Kelley, R. (2005). "Service-Oriented Architecture Helps Carriers Maximize Software Reuse", *National Underwriter. Life & Health*, Erlanger. 109(44), 28.
- Lager, M. (2006). "SaaS: Opening the Hatch(ery)", *Customer Relationship Management*, 10(3), 75.
- Langedijk, M. (2006). "Software as a Service (SaaS) it adds up!", *Accountancy Ireland*, 38(3), 75-76.
- Likert, R. (1932). "A Technique for the Measurement of Attitudes", Doctoral Thesis, Columbia University.
- Lindh, C. (2006). *Business Relationships and Integration of Information Technology*, doctoral dissertation, Mälardalen University, Västerås.
- Lindström, Å., Johnson, P., Johansson, E., Ekstedt, M. and Simonsson, M. (2006). "A survey on CIO concerns-do enterprise architecture frameworks support them?", *Information Systems Frontiers*, 8(2), 81-90.
- Moore, G.C. and Benbasat, J. (1991). "Development of an instrument to measure the perceptions of adopting an information technology innovation", *Information Systems Research*, 2(3), 192-222.
- Mullender, M. (2005). "Razorbills: What and How of Service Consumptions", *The Architecture Journal* 4, available at http://www.architecturejournal.net/2005/issue4/aj4razor_pf.aspx.
- Orr, B. (2006). "SaaS just may be the end of software as we know it", *American Bankers Association*, 98(8), 51.
- Reynolds, M., Crossland, J., Blair, R. and Willis, T. (2001). *Beginning Visual Basic .NET*. Birmingham, UK. Wrox Press.
- Rogers, E. (2003). *Diffusion of Innovations*, 5th edition, New York, The Free Press.
- Shu, G., Rana, O., Avis, N. and Dingfang, C. (2007). "Ontology-based semantic matchmaking approach", *Advances in Engineering Software*, Elsevier, 38(1), 59-67.
- Sundblad, S. and Sundblad, P. (2007a). "Business Improvement through Better Architected Software", *The Architecture Journal* 10, available at www.architecturejournal.net, 2007-06-08.
- Sundblad, S. and Sundblad, P. (2007b). *Software Architecture vs. Software Engineering*, available at <http://www.2xsundblad.com>, 2007-06-08.
- Swartz, A. (2002). "MusicBrainz: a semantic Web service", *IEEE Intelligence Systems*, 17(1), 76-77.
- Van der Aalst, Ter Hofstede, Kiepuszewski, B. & Barros, A. (2003). "Workflow Patterns", *Distributed and Parallel Databases*, 14(1), 5-51.
- Watson, R., Berthon, P., Pitt, L. and Zinkhan, G. M. (2000). *Electronic commerce: the strategic perspective*. Dryden, Fort Worth, TX.

- van den Berg, M. and van Steenberg, M. (2006). *Building an Enterprise Architecture Practice*, Springer.
- Wagter, R., van den Berg, M., Luijpers, J. and van Steenberg, M. (2005). *Dynamic Enterprise Architecture*, John Wiley & Sons.
- Winograd, T. (2006). “Designing a new foundation for design”, *Communication of the ACM*, 49(5).
- Winograd, T. (1996). *Bridging Design to Software*, Ed. US. Articles from a workshop in Stanford.
- Wong-Bushby, I., Egan, R. and Isaacson, C. (2006). *A Case Study in SOA and Re-Architecture at Company ABC*, 39th Hawaii International Conference on System Sciences.

Electronic sources:

- Joakim Sundén’s blog <http://blogg.joakimsunden.se> 2007-06-20.
- Dag König’s blog, Microsoft .net developer and architect, <http://buzzfrog.blogs.com/zabrak> 2007-04-20.
- The Sten and Per blog <http://www.2xsundblad.com/cs/blogs/stenandper>, 2007-06-20.
- Johan Lindfors’ blog <http://blogs.msdn.com/johan>, 2007-06-22.
- Patrik Löwendahl’s blog <http://www.lowendahl.net> „Why SOA is broken“
- International Association for Software Architects (IASA), the Swedish IASA organisation <http://www.iasahome.org/web/sweden> 2007-06-20.
- Swedish IT-architects <http://www.iasa.se/> 2007-06-20.
- International Data Group (IDG), a global provider of market intelligence, website <http://www.idg.com>, 2007-06-22.
- Jönsson & Läpp, four architect courses give a diploma <http://www.jonssonlepp.se>
- Certified Sundblad & Sundblad and Microsoft .NET-architects, total amount of 259 architects, <http://www.2xsundblad.com/se/CertArchitects>, 2007-04-20.
- Hall of Fame Microsoft .NET-architects, published names and companies of all the 259 certified architects, 2007-04-20, http://www.microsoft.com/sverige/msdn/architects/hall_of_fame_200503_2006_01.aspx.
- Dataföreningen’s educations with certification <http://www.dfkompens.se>
- OASIS; non-profit international consortium for adoption of business standards <http://www.oasis-open.org>
- Systemteknik Ab i Eckerö/Finland; using state of the art software technologies and tools to develop the applications and the databases to support them. <http://www.systemteknik.fi/> 2007-02-08
- Ikanobanken: ”Nu skapas fler nya banktjänster” http://web04.microsoft.se/sverige/references/ref_description/2005-05-12_488.htm 2007-02-08.
- Expertzonen <http://www.cornerstone.se/expertzonen/dev/speakers>
- <http://www.itpressen.se/Default.asp?obj=arkiv&id=2616>
- The Enterprise Architecture Research Program, The Royal Institute of Technology (KTH in Swedish) http://www.ics.kth.se/Forskning/Enterprise%20Architecture/Enterprise_Architecture.htm

Seminars

- ”Web Service Factory and the future system architecture”, 2007-03-07, seminar arranged by Jönsson & Lepp at Sergel film in Stockholm. Speakers: Magnus Juvas, Transcendent Group: ”Software Factories in practice” and Daniel Akenine, IASA Sweden: ”The Architect Role today and ahead”.

Films

- ”What is Web 2.0?”, film by the American anthropologist Michael Wesch, available at <http://www.cstjanster.idg.se/c/832>

Business Domain Models as Tools in Development of Enterprise Resource Planning Systems

Signe Ellegård Borch, Renate Kristiansen

IT University of Copenhagen, Norwegian University of Science and Technology

elleborch@itu.dk, renate.kristiansen@idi.ntnu.no

Abstract. Business domain models play an important role in the context of Enterprise Resource Planning (ERP) systems implementations, where e.g. industry specific reference models are used to set up the ERP systems at the end user organisations. In this paper we will focus on another, less researched, part of ERP software practice where business domain models are widely used, namely ERP software development. Our analytical approach is to use the concept of *design artefacts* to describe the role of the business domain models in the development process. Our investigation is guided by the following questions: How can domain models be designed and used as design artefacts in ERP development? How can the models support the dimensions of construction, cooperation and conception within ERP development and what are the problematic issues? What might be the challenges when designing the design artefact itself? We will present a case of model design and use in ERP development based on empirical studies conducted in a large software development company developing ERP software. On the basis of this study we will point at a number of research topics that need to be further investigated.

Keywords. Design artefact, conceptual modeling, software development, ERP systems

Introduction

In Information Systems research on Enterprise Resource Planning (ERP) systems there is a substantial amount of research on the implementation of ERP in organizations, and the problems that may arise in these implementation projects (e.g. Holland & Light 1999, Parr & Shanks 2000). We know less about the

development phase of ERP systems. Since ERP systems are commercial off-the-shelf software, the development of them differs from the development of custom made systems. What is characteristic of ERP development is that

1. the ERP systems are often developed in very big development organizations
2. the developer organizations usually do not have direct contact with the users of the systems, since the core systems are adapted for specific industries by partners, and implemented at the end user organizations by them
3. the systems are not targeted at one particular context of use, but are designed to be generic for a group of customers in a particular market : they are designed, constructed, and sold as a product.

In this paper we will look at the role of business domain models in ERP software development, and how these models can be designed and used as a tool to support the development process.

It is particularly interesting to look at the role of conceptual models in the development processes of ERP systems because of the complexity caused by the characteristics mentioned above. The characteristics indicate different kinds of use for the business domain models: Due to the sheer size of the company developing the ERP software, there is a need for a domain model as a common frame of reference to support communication within the developer organization. Because of the distance between the people developing the software and the users of the software there is a need for useful abstractions of the business domain within development: what does a typical business look like, who are the users, what do they do, what kind of requirements do they have to the system? Since the system is adapted by partners, there is a need for models and modeling tools that support these adaptations.

Designing business domain models to be used in ERP development can be described as a case of *situated model design*. By this we mean that the questions: “A model *of* what?” and “A model *for* what?” should be seen as inseparable: A model is an abstraction of a domain of interest, with a certain perspective, and the design criteria should depend on its use. This perspective is different from more essentialistic approaches, where models and modeling languages are evaluated against formal frameworks (e.g. modeling languages evaluated against the BWV ontology, see Rosemann et al. 2006). In this paper we would like to investigate situated model design by 1. looking at the model as an artefact and 2. describing its context of use, and relating the challenges in the model design process to these two perspectives.

As a theoretical framework for doing this we will introduce the concept of *design artefacts*, as it is described in the context of activity theory (Bertelsen

2000). We find that the terminology presented here is useful when describing the relation between the model and its use context. Especially the distinction between the design dimensions of *construction*, *cooperation*, and *conception* is useful to structure our observations on what part of the ERP software development practice the model is designed to support.

The paper is organized as follows: First we give a short introduction to the concept of design artefacts and the dimensions of design that such an artefact can support. The rest of the paper is devoted to our empirical study: initially, we provide the organisational context of the ERP development company, and describe the research methodology we used to collect our empirical data. Then we introduce the business domain model as a design artefact, describing its design history, current structure, concepts, and notations. Next, we document our observations of the current use of the model in the development organisation, and ongoing design discussions and visions for future use(s) of the model. With these observations as our basis we present the result of our analysis: A number of research topics to be further investigated.

Design artefacts and dimensions of design

We will now introduce the concept of a design artefact, and describe how it relates to the design dimensions of construction, cooperation, and conception in software development. Our definitions of these concepts are mainly taken from (Bertelsen 2000).

The notion of design artefacts that we will use in our analysis has activity theory as its theoretical foundation. It is a basic assumption in activity theory that every human activity is mediated by socially constituted artefacts. An activity changes an object, transforming the object into an outcome, and the artefact is used as a tool in this process. Design can be viewed as a specific human activity, and the artefacts used here are named design artefacts: “design can be characterized as an activity where a designing subject shapes the design object by means of some design artefacts” (Bertelsen 2000).

However, the design artefact used as a tool is not neutral, but determines the perspective the designer has on the design object: “The “tool” is at the same time both enabling and limiting: it empowers the subject in the transformation process with the historically collected experience and skill “crystallised” to it, but it also restricts the interaction to be from the perspective of that particular tool or instrument only - other potential features of an object remain “invisible” to the subject.”(Kuutti 1995) .

The designing subject is not necessarily an individual person - usually there are a number of people involved in a design process: most prominently the designer who shapes the design object, and the future user of the object.

Design processes normally involve even more people: design activities are carried out within a complex social context, with rules and division of labor. The design artefact has an important role as a facilitator of cooperation between these (often heterogeneous) groups. The design artefact makes it possible to share design-oriented knowledge between different stakeholders, also independently of project phases and physical settings.

Software development is one place where design processes occur, and where design artefacts are used. Examples of design artefacts in software development are: programming languages, system development methods, specification standards, computer-aided software engineering (CASE) tools. In (Bertelsen 2000) three dimensions of design are described in relation to software development: *Construction*, *cooperation*, and *conceptualization*. Design artefacts have a mediating role in all three dimensions:

1. “Construction is the productive relation between the designing subject and the object of design”. The construction of software is an engineering process, where e.g. programming languages are used as tools.
2. “Cooperation is the representational relation between subjects involved in design”. Prototypes and conceptual models are examples of design artefacts that mediate cooperation in software development.
3. “Conception is the dialectical relation between the designing subjects and the historically developing activity”. The dimension of conception in design becomes obvious when e.g. new design artefacts are introduced into a design practice – it could be a new programming language paradigm or prototypes that give rise to alternative perspectives on the current design practice. Thus conception is closely connected to learning.

Research methodology and organizational context

The empirical study that we will present below is based on field studies conducted in a large software development company, called ProERP in this article, developing ERP software. Part of the material was collected at a prolonged field stay of some months in spring 2005, and the rest of the data was gathered in winter and spring 2007. Our focus in this paper is on the data that has been collected most recently. Methodologically, we have used the principle of triangulation (Yin 1994). Thus, the material we present is collected by using different qualitative empirical methods such as participant observations, structured and unstructured interviews, as well as the reading of project specific documents and texts. Also we have had a hands-on experience with some of the tools that have been developed. The collection of data, and our interpretation of it,

has been guided by the principles of interpretive field studies described in (Klein and Myers 1999).

The development organization is divided into groups of professions: e.g. people specialized in user interface design is in one group, and technical developers are in another group. For the individual development projects, cross-disciplinary teams are formed, so that people with different professional knowledge can contribute to the project.

The organizational culture can be described as a culture of innovative engineering. There is a tradition for prototyping, and trying out new ideas from the bottom of the organization. The bright idea is highly valued, especially if it is backed up by some technical implementation, e.g. a prototype. These prototypes are showed at demo-sessions, and possess strong rhetorical power. Selling the projects at presentations and demo-sessions is a way of promoting the projects and getting management's attention, with the potential of getting more resources.

The company is geographically scattered, and the projects cut across national borders. There is cooperation, but also competition, between the different sites. Some of the cooperation between the sites takes place by mail, and by telephone conferences. There are also meetings where all participants are physically present, and people visit from the other sites to participate in longer workshop sessions.

A number of smaller companies developing ERP systems have been acquired by the company – these systems are still maintained, and there is a need to integrate them, and eventually design a new ERP system built upon the best parts of each system.

The Business Domain Model

We will now describe the business domain model as a design artefact: its structure, representation and how it is communicated within the ERP development organization.

With the goal of creating a joint understanding among the ERP developers of the business that needs to be supported by an ERP system, a model describing the end users' organization and work has been created - we call it the *business domain model*. The business domain model consists of two separate parts, one part describing organizational structure and employees and one part describing what business processes the end user organization has. This separation stems from the fact that the two parts of the model historically have their origin in different teams within ProERP. Both parts are now owned by the team working with usability: User Interface Design team.

User and organizational model

This part is based on extensive user studies including ethnographical studies, field studies and usability studies in labs. The result was a generic model of the end user organization and its employees. The employees are described using Personas, a technique introduced by (Cooper, 1999) and used in software development projects (e.g. Pruitt & Grudin, 2003). A Persona is an archetype of an actual user and provides a shared basis for communication around end users and their world. ProERP use a template giving an extensive description of the fictive person including demographics, work environment and goals, roles within organization, core activities, closest collaboration partners and a description of a typical day at work. The numerous Personas are grouped into departments, and each department is illustrated by organizational charts. In this way ProERP has created their own fictive company world, and they can have discussions about e.g. Brian - the manager for the HR department – what needs does he have with regard to some new functionality in the software?

As the complexity and size of the companies supported by the ERP system varies considerably, ProERP has found it useful to create virtual companies of varying size and complexity. E.g. Anne is manager for three different versions of an HR department: a large, a medium and a small department.

Business process model

This model has its origin in the part of the development organization involved in planning what functionality should go into new releases of the ERP software. The team responsible for this task had a need for a high level description of which processes a business typically has. The model is a description of what a generic company could look like from a business point of view, and it is not related to what processes the ERP system supports.

The model is basically a supply chain model that is decomposed into process elements. These elements are grouped together and placed within departmental borders, showing which department has the responsibility for which processes. Figure 1 shows the process steps that are part of the Project Management process. (The information in the figure is fictive). This process (and a number of other processes) are placed under the Project Management departments' responsibility.

Project Management department - manage project process

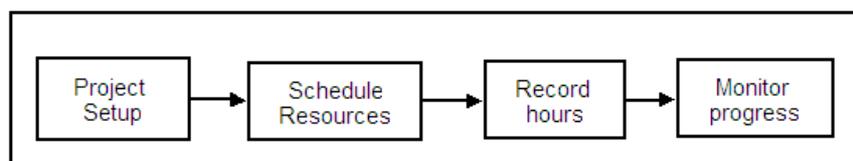


Figure 1 - high level description of project management process

The process steps are further decomposed into BPMN diagrams showing which activities are typically carried out to execute the process.

Representation and communication of the model

The model is known to every ProERP employee through posters pinned up on the walls around the company. Because of the limited size of a poster, the information visualized on the poster is high-level, and might work as a teaser for people so that they want to learn more about the details. Today the business process model and the user and organizational model are represented on separate posters. Attempts have been made to combine the information from the two parts of the model, creating a new poster which visualizes which Persona does which activity in what sequence, in the context of one specific business process (e.g. in the project management process shown in figure 1). However, the problems of making a visualization of the model that provides both an overview and a sufficient level of detail have not yet been solved - the current version of the poster is interpreted as too “messy and information intensive”.

More detailed information (as the BPMN diagrams and the complete Persona template) can be found in a repository accessible through the ProERP Intranet. Here the information is structured so that it is possible to unfold the high level representations and get more details. An application with the same functionality is under development, but this tool structures and visualizes the information in a different way that we will not go more deeply into here.

The Business Domain Model in use

In this paragraph we will give some examples of how the business domain model is used as a design artefact in the design dimensions of construction, cooperation, and conception. First we will describe how the model is a part of the current design practice, and then we will present some of the discussions and visions about new ways to make use of the model.

Current use

The business domain model is used as a resource in the current development practice in different ways. However, it also has its limitations - when used it often has to be moulded by the different project teams so that it fits their requirements and situation. The examples below will illuminate these issues.

Construction

Information from the Persona part of the business domain model is used as a starting point for developing scenarios. A scenario is a story that describes the human activity when a user is trying to reach her goal (Preece, J. & Rogers, Y. & Sharp, H., 2002). An example of this use of the model is when a person from the User Interface Design team develops a scenario for how a purchase requisition is created. The user interface designer looks to the business domain model and finds the Personas that need to participate in the task – which in this example would be John from the sales department, Peter from logistics and Hannah who is the sales department manager. All information about the involved Personas is read through and they are then used as the leading actors of the scenario “Create purchase requisition”. The textual description in the scenario is supported by a workflow diagram showing which Persona has the responsibility for which subtasks in the “Create purchase requisition” task. In this way the business domain model is directly used in construction and the Persona is indirectly visible in the software as the different screens are designed with the requirements from specific Personas in mind.

One problem while using the information from the business domain model in the design process is that the level of abstraction is too high. A comment from one developer: “It is a nice way to get an overview of the business domain if you don’t know anything beforehand – otherwise it is simply not detailed enough”. The details of how a purchase requisition is created must be provided from domain experts, typically people from the project team who are specialized in writing functional specifications. One user interface designer explained how she read about a Persona on the website in order to gather domain knowledge in the initial phases of a project. Further on in the project, this knowledge was not sufficient but had to be complemented.

Much information resides in the documentation that is produced during a development project, e.g. in scenarios. During interviews we discovered that different user groups found it necessary to extend/mould the Persona description according to the situation. For example Hannah – the sales department manager - would have some tasks that differ depending on whether it is a local department or a global international department she is leading (e.g. issues related to currency conversion). A user interface designer said that in her last project she had developed three different versions of Hannah: Hannah.local, Hannah.global and Hannah.international. Routines for how to extend the model with new concepts and structures to encapsulate the new knowledge acquired in the different development projects do not exist. Each project has its own project directory where all documents produced during the project are stored. Reuse of knowledge is hence dependent on people knowing in which project directory to search.

Cooperation

Today the business domain model is used to inform the different development teams about end-user requirements – as a common frame of reference across the company. As mentioned above, the ProERP employees are divided into teams. Each team has its own professional identity and the team members have only limited knowledge about the competencies of other teams. Development project teams are formed as cross-disciplinary teams ensuring that people with different professional knowledge contribute. The concepts of the business domain model found on the posters are recognized by every person on a project team – this makes it a starting point of discussions, because there is already some shared knowledge about the domain to build upon. Everybody “knows” Hannah: she can be referred to as a named person (even with a photo) and not only as an abstract function in an organisation (the sales manager). The details in the business domain model is however not uniformly agreed on which we could see from a discussion between the User Interface Design team and the team responsible for developing tools for the partners that implement the ERP systems - we call it Partner Tool team here - concerning the difference between the role concept and the Persona concept. The Partner Tool team did not see the need to distinguish between these concepts, while the User Interface Design team emphasized the difference.

When new features are designed they are targeted at a specific Persona and the Persona description is used as a basis for recruiting persons that should participate in usability tests. This ensures an alignment of these two parts of the development process.

Conception

The posters are displayed everywhere – in the canteen, in meeting rooms and in offices. The concepts of the model are “naturalized” and become part of the professional vocabulary of the different teams in the development organisation. It is generally accepted to talk about the end users of the ERP system as Personas, and to let these discussions on Personas enter into the development practice. In this way, a more user-oriented discourse is introduced into an organisational culture that typically has a more technical focus.

Future use

In the last year, the business domain model has not been discussed or developed further. It has been integrated into the existing design practices of the development company without anything being changed or added. However, it has now been taken up again by several teams in the company. These teams plan to

extend the use of the model, which gives rise to discussions on whether the model design fits the envisioned use.

1. Construction

One question that has been asked is: When the business domain model is seen as such an important thing in the development company, why is it not directly a part of the software? Couldn't it be used more technically to improve the ERP systems that are developed, instead of mainly being used for internal communication?

One vision is to base the ERP system on the business domain model and ship the model together with the ERP system, making it a model of the application instead of a model of the business world. The gain for the implementation partners of ProERP would be considerable, as it would be easier to visualize what processes the software actually supports and how they are executed. Configuration could then be done by changing the model and in this way empower the end user organization by letting them maintain their own company specific business domain model.

However, there are no current plans for designing a completely new model-driven ERP system. The aim is instead to connect the business domain model to the ERP systems so that the business domain model can be used as a documentation of the ERP system; hence the model should be changed from being a model of the business world to be a model of the application. The ERP system and the model should live side-by-side which means that problems that usually appear with legacy systems have to be dealt with, e.g. problems with mapping the newly introduced concepts of the model to the already existing ERP systems that are built upon another paradigm. The existing ERP systems are menu based, document and data centric, not process centric, and this causes problems in the mapping of the concepts: One example is that the form (a window corresponding to a paper form, where the user can view and enter data, e.g. a sales order) is the smallest conceptual component in the current systems. The problem is how to map an ERP system to a model that has a much finer granularity (e.g. the concept of a task, as "find product number")?

One approach to connect the generic model to the current ERP systems is to "refine" the generic and domain specific concepts of the model into more software specific concepts at the lower levels of granularity. This idea is very similar to the way models are transformed in the Model Driven Architecture (MDA) approach (www.omg.org/mda). However, the relation between the layers in the model is not perceived as transformations (that e.g. in the MDA world means adding design specific information), but simply as the model on different levels of *granularity*. Thus, the traditional distinction between analysis and design models (Mathiassen, A. & Munk-Madsen P. A. & Nielsen & Stage J., 2000) is not explicit - at least not consciously reflected in the discussions that we have observed.

If the business domain model was to be built into the ERP software, the requirements for its rigidity and formality increases considerably compared to when it is used mainly as a communication artefact. E.g. the concepts in the

model must be well-defined and not as open to interpretation as they are today.

2. Cooperation

A number of challenges arise from the fact that different groups are meant to use the same model. Should different versions of the model exist, depending on the use? Is there a conflict between the wish to have a shared vocabulary and to have a model that is useful in the individual projects? Is the model going to be changed for each project it is used in, or can it be shared across them? It is accepted that new uses of the business domain model will result in new requirements for it – increasing its size and complexity. Having different views on the model for the different teams and projects is seen as a possible solution.

We observed a discussion between members from the User Interface Design team and members from the Partner Tool team concerning how to adapt the business domain model to be used in a new tool they plan to develop. The tool is to document the ERP systems' functionality by visualizing the business processes that the system supports. The main goal is that partners should be able to use the tool for gap-fit analysis between the end user organisation and the ERP system. Hence, what they want is a tool that the partners can use in their implementation projects and that documents the existing ERP system in models. This differs fundamentally from the understanding of the business domain model as a generic analysis model, independent of any software specific issues. There is a great challenge in making clear definitions of the concepts, and to get a consistent use of the vocabulary. Also the basic structure of the model is a source of debate. Discussions on the hierarchical structure of the concepts are common, posing questions such as: Is an activity a set of tasks? Is a task atomic? Should tasks themselves be structured in a decomposition scheme (tasks, subtasks)?

There have been discussions on how to deal with the “versioning” problems of the model between different teams: One suggestion was to let the User Interface Design team, who is currently in charge of the model, decide on the definitions. As one of the persons in the Partner Tool team put it: “We will inherit whatever definitions you come up with”. This comment can be seen as an acknowledgement of the importance of knowledge sharing across team borders. The definitions of the concepts that the User Interface Design team gives are accepted by the Partner Tool team “as long as we can consume your data, and you can consume ours”. However, this might conflict with the different uses that the teams are going to make of the model. We have observed inconsistent use of the concepts in the business domain model – especially across teams. E.g. the difference between a Persona and the concept of a role was confusing members of the Partner Tool team, who couldn't see the importance of maintaining this distinction. The User Interface Design team has come up with a metaphor they find useful to distinguish between the two

concepts. They consider the role concept as a hat that a Persona can wear. A Persona can own several hats, but only wear one at a time. However, if this distinction is not considered important by the Partner Tool team, it is most likely that they will not use it in their design practice.

3. Conception

As previously mentioned, the business domain model consists of two separate parts, each giving a different view on the business domain. There is a challenge in integrating the two parts of the model: the business process model, and the user and organization model. As mentioned above, there have been experiments on how to draw a diagram that integrates the role and process perspectives. In the current use, it is mostly the user and organization part that is used, e.g. when building scenarios: the work of one individual Persona is modeled, but there is no process-oriented models describing how the Personas' work contributes to the overall business process.

In the current ERP systems, neither the process nor the role perspective is present. The use of the model in the development practice might be a way to gradually introduce these perspectives into the systems. In addition, on the long run, the use of the model might also have consequences on how the end user organizations perceive their businesses: Since the companies that use the ERP systems do not necessarily have a process-oriented perspective on their own company, the integration of the business domain model into the ERP systems and ERP development practices (like partner implementations) can eventually bring about changes toward process-orientation in the end user organizations.

Research topics to be further investigated

On the basis of our empirical investigation we will pose some research questions that will direct our future research effort. We have grouped the questions in accordance with the structure of the discussion in the previous sections.

1. Construction:

- Which constructs and concepts must be present in the *analysis model* to capture the knowledge that is useful to the different user groups?
- Which constructs and concepts must be present in the *design model*?
- How can the mapping between the analysis and design model be supported?

2. Cooperation:

- How to use a generic business domain model as a shared point of reference and a boundary object?
- How can the model be specialised in order to be useful?
- How can locally achieved knowledge be captured?
- How to assure that the model maintains identity (in the concepts and the structure) but is still utilized locally?
- Are the different uses of the model (technical or communicational) a problem or a benefit - does the model mediate between these practices, or is it a clog?

3. Conception:

- How to merge the two perspectives on the business domain (role and process) in one model?
- How to let these conceptualizations get into the design practices to improve them?
- How to make the model support the effort of making process and user centric applications?

To answer these questions, we will do further empirical studies to get a deeper understanding of the use of the business domain model and the requirements from its diverse groups of users. As we engage in answering our research questions, we will introduce some changes to the design artifact - the business domain model - which can potentially change the development practice. E.g. by making the organization aware of the distinction between the analysis and design models we might introduce changes in the design practice that we observe.

Related research

The use of business domain models in ERP development is common practice, e.g. SAP documents all system functionality in a reference model using the EPC modeling language. However, the EPC models are only used for documentation purposes, and not for model-driven development, e.g. as it is envisioned in the OMG Model Driven Architecture community (www.omg.org/mda). An ERP project that did use a design model that was transformed into programming code was the GUITAIRE Espirit which was a cooperation project between researchers and industry people (from the ERP development company Baan) which developed a user interface generator that generated UI for an ERP system using ConcurTaskTree (CTT) task models and the company's guidelines (Paternò & Santoro, 2003).

In (Floyd, Ukena 2005) the notion of *situated ontologies* is presented. A situated ontology is a taxonomy that is formalized according to its context of use,

and not in relation to formal design criteria. In relation to the work presented in this article, situated ontologies can be seen as design artefacts, and the methods to design situated ontologies, using e.g. iterative prototyping, could also be used when designing design artefacts.

The concept of design artefacts is related to the concept of *boundary objects*. There is a substantial body of empirical research in this field, e.g. on classifications and taxonomies (Bowker, Star 1999). A boundary object is a design artefact that transcends different communities of practice by adapting to different situations and contexts of use while maintaining identity.

Conclusion

In this article we have presented empirical findings from field studies conducted in a large ERP development organization. We have documented how a business domain model is used as a design artifact in different parts of the development practice and discussed several of its limitations with regard to its current and envisioned future use. Our observations have been structured and analyzed according to the design dimensions of construction, cooperation, and conception. On the basis of this analysis, a number of topics for further research have been identified.

References

- Bertelsen, O. W. (2000). "Design Artefacts: Toward a design-oriented epistemology", *Scandinavian Journal of Information Systems*, vol. 12.
- Bowker, C. G.; Star, S. L. (1999). *Sorting things out: Classification and its consequences*, Cambridge: MIT Press.
- Cooper, A. (1999). "The inmates are running the asylum: Why high-tech products drive us crazy and how to restore the sanity". Sams Publishing.
- Floyd, C.; Ukena, S. (2005). "On Designing Situated Ontologies for Knowledge Sharing in Communities of Practice", Workshop on Philosophical Foundations of Information Systems Engineering, Proceedings of the CAISE'05 Workshops, Vol. 2.
- Holland, C. R.; Light, B. (1999). "A Critical Success Factors Model For ERP Implementation". *IEEE Software*, vol. 16, issue 3.
- Klein, H.; Myers, M.D. (1999). "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems". *MIS Quarterly*, vol. 23, No. 1.
- Kuutti, K.(1995). "Activity Theory as a potential framework for human-computer interaction research", In: Nardi, B. (ed.): *Context and Consciousness: Activity Theory and Human Computer Interaction*, Cambridge: MIT Press.
- Parr, A. N.; Shanks, G (2000). "A taxonomy of ERP Implementation Approaches". Proceedings of the 33rd Hawaii International Conference on System Sciences.

- Pruitt, J. and Grudin, J. (2003). "Personas: Practice and Theory", In Proceedings of the 2003 conference on Designing for user experience, San Francisco, California, June 06 – 07, DUX '03. ACM Press.
- Paternò F. and Santoro C. (2003). "A unified method for designing interactive systems adaptable to mobile and stationary platforms", *Interacting with Computers*, vol. 15, No. 3
- Preece, J. and Rogers, Y. and Sharp, H., "Interaction Design: beyond human-computer interaction", John Wiley & Sons, Inc, 2002
- Rosemann, M. et al (2006). "A study of the Evolution of the Representational Capabilities of Process Modeling Grammars". *Proceeding of Conference of Advanced Information Systems Engineering 2006*.
- Yin, R. K. (1994). *Case Study Research: Design and Methods*, 2. edn, Sage Publications.L.

Communication and Information Exchange among SMEs and their Local Environment

Viveca Asproth, Christina Amcoff Nyström

Department of Information Technology and Media, Mid Sweden University, Östersund, Sweden

viveca.asproth@miun.se, christina.amcoff@miun.se

Abstract. In this paper the results from a pilot study in the project “Arena for Sustainable Innovative Development of small and medium-sized enterprises”. The project aims to create and test a model for collaboration and sustainable development among small and medium sized companies in local areas. The questions raised in the study were: What kind of problems and requirements can be found in small enterprises with respect to information exchange and communication with others? Which information is needed to promote active engagement among the interested parties? How does the knowledge creation and exchange work between the actors? The method used was qualitative and explorative with semi-structured interviews.

Keywords. Communication, SME, information exchange, ICT, organizational learning

Introduction

Collaboration between companies is resulting in a range of important outcomes for the collaborating parts. Collaboration not only transfers existing knowledge among organizations, but also facilitates the creation of new knowledge and produce synergistic solutions. Organizations can also achieve a more central and influential position in relation to other organizations through the collaboration (Hardy, et al, 2003). To achieve the positive effects with collaboration, communication and information exchange between the companies must be

efficient. Much of to-days communication and information exchange between companies are often sporadic and isolated.

According to Zakaria et al. (2004) the human challenges of virtual team membership are:

- Creating effective team leadership
- Managing conflict and global virtual teams dynamics
- Developing trust and relationships
- Understanding cross-cultural differences
- Developing intercultural communication competence

Handy (1995), Maznevski & Choduba (2000), and Crossman & Lee-Kelley (2004), among others, claim that “trust needs touch” at least in the initial stage. Crossman & Lee-Kelley (2004) conclude that low commitment from the individual leads to low trust and that team effectiveness is inhibited, yet organizational efficacy in dispersed teams requires high mutual commitment and high trust. They also conclude that trust takes time to develop.

Holmqvist (2003) and Rashman & Hartley (2002), recommend organizational learning as a tool to, in the first place, develop an intercultural communication competence, but also as a complement learn more about each other.

The use of organizational learning within an organization has shown to be successful. The question is how to transfer the concept to inter-organizations. There might be competitiveness and conflicting interest that put hindrance in the way. (Asproth, 2006)

To increase the possibilities for fruitful collaboration between SME¹s in geographically delimited locations in a peripheral region a research project has been initiated. The research project is in an initial phase and a pilot study has been carried through.

The project

The research project ”Arena for Sustainable Innovative Development of Small and Medium-sized Enterprises” is a co-operation between Mid Sweden University, the county administrative board, the local authority of the city of Östersund. The project aims to create and test a model for collaboration and sustainable development among small and medium sized companies in local areas. In the project two industrial areas, Odenskog and Lugnvik, are taking part. A third constellation of companies working with vehicles, Vehicle Technical Center (VTC) is also incorporated in the project. VTC is a co-operation of interested parties with their background in either military vehicle education or civil enterprises with connection to vehicles. The area of Odenskog is characterized by increasing heterogeneity among the enterprises and trading. The

¹) The concept of SMEs – Small and medium-sized enterprises is equal to the concept of SMBs – small and medium-sized businesses. According to the Statistics Sweden, this is enterprises with 0-49 employees.

interested group, representing most of the enterprises in the area, wish to remove the label as a “traditional industrial estate” in favour of trading and visiting customers. This is to some extent in conflict with the existing city planning due to limited permissions to establish new kinds of trades. The first enterprises in the other district – Lugnvik - moved from Odenskog in the 1970s and were earlier characterized as enterprises demanding large spaces such as hauliers, scrap yards for old cars, and localities for building materials. The district today has problems with respect to lack of uniform displaying and problems for customers to find in the area. The interested group in the area runs a project with the aim to clean up the area and produce uniform displays and enterprise signs.

The overall aim with the project is to create and test a model for collaboration and sustainable development among small and medium sized companies in local areas.

Questions to be answered are:

- What kind of problems and requirements can be found in small enterprises with respect to information exchange and communication with others?
- Which information is needed to promote active engagement among the interested parties?
- How does the knowledge creation and exchange work between the actors?

An initial pilot study, aiming to investigate necessary conditions for collaboration between small enterprises, supporting systems run by the local authorities and higher education, in order to reach sustainable development of the trade and industry was carried through. In this paper the part of the investigation concerning communication and information exchange is in focus.

The research question in this article is delimited to issues concerning *information exchange and communication among* the interested parties.

Method

The method used in this pilot study was qualitative and explorative. The study was carried through with help of semi-structured interviews. Fifteen representatives for the trade and industry representing the three company clusters, representatives for the local authorities and seven representatives for the University have been interviewed. The participants from the three company clusters have been selected mainly based on their representation of either businesses belonging to service sector, production or trading but also the fact that they represent different businesses sizes. Representatives from the local authorities and the University have been selected with respect to their experiences with collaboration with SMEs. An interview guide was constructed. The guide was divided into questions about collaboration between companies, co-operation with the university and support from the local authorities and questions about

communication and information exchange. The part of the guide containing questions concerning co-operation with the university was used for the university interviews as well as the part of the guide containing questions about support from the local authorities was used for the local authority interviews.

Ongoing research - ICT and small enterprises

This section presents ongoing research and findings in the area of ICT² and small enterprises (SMEs).

Networks and their importance for SMEs

Several researchers concludes that there are great advantages for firms to cooperate in clusters (Becattini et al., 1992; Enright, 1995; Maillat et al., 1995; Piore and Sabel, 1984; Porter, 1998). Accordingly, Carbonara (2005), discuss the advantages of cooperating in cluster:

Clusters base their competitive advantages on two distinctive aspects: the inter-networking processes and the speed and easy circulation of information and knowledge. Hence, a cluster can be seen as an extended enterprise where the different actors (the cluster firms) are usually specialised in single manufacturing phases that require intense coordination, flexible relationships and appropriate supporting tools to manage the networking activities.

World Wide Web (WWW) offer great opportunities for SMEs to extend their customer base into the global marketplace (Tetteh and Burn, 2001). However, there is a need to adopt a different approach to strategic planning and management which can enable an extensive infrastructure network based on shared resources with other firms. Accordingly, SMEs could save costs if they share resources with others and carefully analyze and plan for e-businesses. Internet technology offers in general advantages for businesses to collaborate (Power and Singh, 2007).

Use of technology demands Organizational change in SMEs

SMEs as well as any type of organization, could be analyzed from different points. One way to get a comprehensive view would be to study organizations as the fusion or synergism of four spheres – Competence of human skills, Management, Organization, and Technology (Holmberg 2001).

²) The concept ICT is an abbreviation for Information and Communications Technology. The difference from the concept IT is that the focus of Communication have been highlighted in the first concept while it was implicit in the latter definition

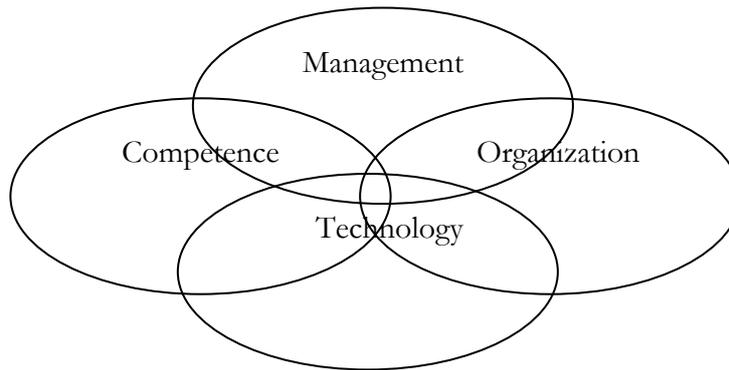


Figure 1. Synergy-4, adapted from Holmberg (2001)

We agree with Holmberg (2001) that the interdependence of the spheres has been ignored or even omitted in development and maintenance processes of organizations. The focus is normally only on one sphere at a time.

The adoption of technology in organizations differs. According to SMEs, recent data on the diffusion and adoption of ICTs show that the ICT penetration is still quite low among SMEs (Eustostat, 2002; IDC, 2000; OECD, 1998, Carbonara, 2005).

It is well known that Internet based technologies and other ICTs offers great opportunities and advantages for organizations as a foundation for collaboration – both within the organizations as well as between organizations. Hence, Power and Singh (2007) among other, concludes that the application of Internet based technologies provides significant potential opportunities for integration of business processes between firms (Power and Singh, 2007 referring to Cagliano et al. 2003 and Segev et al., 2003). Benefits based on this integration could for example be reducing costs for searching for and accessing information (Berthon et al., 2003; Krumwiede et al., 2003), but limiting factors could also be the increase of information processing and coordination costs because of the reducing of transaction costs (Kulkarni and Heriot, 1999).

Organizations implementing Internet technology in order to create more integrated supply chain will probably be confronted with the need for structural change (e.g. Power and Singh, 2007; Reid and Catterall, 2005). This change could mean a need to develop new processes (e.g. Jayaram et al., 2000; Mitev, 1996) or involve new structures, roles and competencies for management of such process (Malhotra, 2000; Power 2004). This is in line with the Synergy-4 Model by Holmberg (2001). If new technologies are implemented to support inter-organizational collaboration, an analyze concerning the structure of the organization, the processes and the management as well as the competence in the

organization and necessary measures should be carried out (the other spheres in the Synergy-4 model).

According to Rabinovich, the Internet and the Web may have had the most profound impact on business integration and collaboration of all information technologies (Rabinovich et al, 2003). Sanders defines e-business technologies as the Internet, Web and web-based applications (Sanders, 2007). Findings show that the use of e-business-technologies has a positive impact on *intra-organizational* collaboration (collaboration between organizations) as well as *inter-organizational* collaboration (collaboration between two or more departments *in* an organization). Furthermore, the existence of *inter-organizational* collaboration has also a positive impact on *intra-organizational* collaboration (ibid). Use of e-business technologies, inter- and intra-organizational collaboration has positive influence on organizational performance (ibid). However, Sanders point out the fact that collaboration is not synonymous with e-business technology use which wrongly has been presumed by a lot of companies. Collaboration is according to Sanders:

a result of human interaction which can only be supported by IT, one of which are e-business technologies, but not replaced.

Companies should therefore consider investing in e-business technologies in order to promote internal collaboration.

IT can be aggregated into several categories. Barki et al (1993) have divided IT into six categories as follows: transaction processing systems, decision support systems, inter-organizational systems, communication systems, storage and retrieval systems, and collaborative work systems. Another categorizing is provided by Kendall (1997); production oriented information technologies and coordination oriented information technologies. Some of these ITs might have more impact on collaboration and integration than others which future research should consider (Sanders, 2007).

SMEs and collaboration with the environment – conditions and obstacles

Vescovi (2000) has identified “six natural troubles” related to SMEs in introducing e-communication. It should be noticed that this “troubles” not necessary appears at the same time. The “troubles” are:

- (1) Unclear communication strategy
- (2) New communication paradigms;
- (3) Non-integrated marketing communications;
- (4) Company involvement in the Internet challenge;
- (5) People for Internet communication; and
- (6) Organizational change.

The first “trouble” – unclear communication strategy - could be related to a waiting attitude to the use of the own Web site where absence of purpose and strategy are common. Several researchers (Schlosser and Kanfer, 1998; Vescovi, 1998) pointed out a prevalent attitude of undervaluing the updating and vitalising problems of the web site. The absence of strategies could also be related to development of Intranet as a common problem (Bank and Nyström, 2005; Nyström 2006).

To solve “trouble” number two – new communication paradigm - diffusion and access to computers and computer competence is needed. The attendance “on the Net” demands also quick responses because of the changed expectations (Vescovi, 2000). Bank and Nyström did also notice the problem with poor access to the Intranet caused by limited number of computers among assistant nurses which caused uninformed employees (Bank and Nyström, 2005).

The presence on the net – trouble” number three - demands coordinated marketing strategies so the Web site shows a uniform view of the company according to contact information and so on.

The fourth “trouble” – company involvement in the internet challenge - addresses issues as patience and carefully planning. The result from marketing activities through the Web site does not come immediately. Request for a strong cultural change, long time needed for the results, and the investment in continuous updating processes create quick enthusiasms and fast disappointments (Vescovi, 2000) – “trouble” number five – people for internet communication.

The focus when developing Web sites has been too much on technical solutions. Vescovi (2000) argues that marketing competencies must enter the stage in order to market the companies better.

The last “trouble” - Organisational change - demands that the entire organisation has competence to use the technology. This is in line with the idea of Synergy-4 by Holmberg (2004) who argues that change in the technology demands an overhaul of competence, management and organisation.

SMEs could increase their level of competence and power of attraction in several ways. One way is to use ICT in different ways – when collaborating and so on. Another way is to adopt the idea of Knowledge Management in a systematic way. Wong and Aspinwall (2005) have in a study, systematically determined the Critical Success Factors for Knowledge Management implementation in the SME sector. Their study offers information to SMEs which, according to the authors, are still lagging far behind when it comes to Knowledge Management practices.

Results of the pilot study

The use of websites and intranet

Most of the enterprises websites were mainly used for publishing. Collaboration and more advanced use modes were only found among enterprises belonging to a group of companies. Several web sites were designed as one-way communication – pushing of information. Some of the interviewees also mentioned the risk with publishing to trivial information on the Intranet though more important issues disappeared (information overload). Several interviewees mention the increased importance of updated and informative websites with respect to new markets in Asia. In general, the information retrieval from different websites was increasing and the possibility to subscribe for newsletters were used more than before.

Communication

Personal meetings, cellular phones and e-mail were mentioned as very important when the interviewees were communicating with external parties. Communication through e-mail should be preceded by a personal meeting if the contact would remain and long-term collaboration will be established. Personal meeting must be effective with a clearly outspoken purpose, and end with a plain contract. The contract must also contain questions left to the next meeting and meetings must be documented. Contact with customers was experienced as more and more important and the number of personal contacts increased. Some of the interviewees experienced use of e-mail to be problematic with respect to information overload (spam). Some interviewees used their secretary function as a filter while others did not experienced information overload as any problem. The amounts of undesired information were experienced to increase. Someone explained the problem with too much information it as a matter of prioritization “the customers are most important, than comes the suppliers and last the authorities”. Some sellers in a business, who worked in the field, had desired more contact and communication with their other fellow workers. The businesses had solved this desire with phone meetings every month which worked well. The businesses in VTC communicated primary by public information meetings and secondary by arena meetings/discussion groups. Thirdly, the website was used for information exchange.

Information exchange

Everyone thought information exchange to be difficult. There is a lot of noise. Some businesses are sending information to their employees in the pay envelope while others uses weekly meetings. In the work with information exchange, It is important to think about the purpose, costs and estimated benefit related to the information. Updating information was among several interviewees experienced

as difficult and a problem. Some businesses, who worked with projects, used a common database connected to a project management system. This was believed to be a condition to ensure that everyone had proper information.

Technology matured businesses

Some of the businesses in the study used more advanced technology than others and were also using the technology in a more advanced mode. These firms felt it nature to use online chat functions with web cameras as a similar communication channel as videoconferences (but simpler and cheaper). These firms demanded more functions to support online communication. The Intranet in one of these businesses was totally integrated with the business system in the business. Some other interviewees also mention web meetings where computer and phone are used together. These communication modes presuppose that the parties know each other before and personal meetings have already been carried out. "There is no problem with new technology but the maturing should be high" as someone said. One of the interviewed businesses has an operator solution in the form of "round robin" where everyone in the business is connected and the first unoccupied telephone line (cellular phone) works as an operator.

Electronically discussion boards and Bulletin Board Systems (BBSs)

Most of the interviewees had not heard about systems like BBSs or computer based conference systems. None among the interviewees were using such systems. Someone mention the problem to adapt new technology. ICTs are supposed to be effective, but what is affectivity? Quality is not especially effective and vice versa. It is difficult to measure effectiveness in ICTs.

Concluding remarks

Some of the factors identified by Wong and Aspinwall (2005) that are important for SMEs in their work with adopting Knowledge Management are also present in the results from the study of SMEs presented in this paper. The factors are application of technological tools such as collaborative tools, knowledge bases etc, utilisation of the intranet or internet and ease of use of the technology.

Several of the businesses in the study pointed out the same "troubles" as Vescovi (2000): unclear communication strategy – or lack of, company involvement in the internet challenge – poor matured websites and no strategy for how to use the internet in a strategic manner, organizational change and the increased importance of updated websites.

Adoption and diffusion of technology should also be considered together with changes in the organization, updating of competence and procedures as well as an overhaul of the management of the businesses (Holmberg, 2001).

Collaboration can be viewed in stages – from simple information exchange to true collaboration (Sanders, 2007; Sabath and Fonatanela, 2002). Sanders suggest that future research should consider the relationship between specific types of IT and their linkage to specific collaboration needs.

Several questions were identified in the study. Some of these questions concerned issues about knowledge management, adoption of ICTs, maturing in use of ICTs related to communication modes, and importance of communication strategies. The project will now continue with deeper studies base on the results from the pilot study.

Acknowledgements

This paper is part of the project “Arena for Sustainable Innovative Development of Small and Medium-sized Enterprises”. We would like to thank the project leaders and the interviewees in the participating constellation of SMEs.

References

- Asproth, V. (2006). “Inter-organizational management and decision-making” *Systemist*, vol 28, no 2, 4-12.
- Bank, B., Nyström, C., A. (2005). ”Intranet Use – A study of Five Swedish Organisations”. *Journal of Organisational Transformation and Social Change*. Vol 2, no 2, 153-180.
- Barki, H., Rivard, S., Talbot, J. (1993). ”A key-word classification scheme for IS research literature: an update.” *MIS Quarterly*, vol 17, no 1, 209-226.
- Becattini, G., Pyke, F., Sengenberger, W (eds), (1992). *Industrial Districts and Inter-firm Co-operation in Italy*, International Institute for Labour Studies, Geneva.
- Berthon, P., Ewing, M., Pitt, L., Naude, P. (2003). “Understanding B2b and the Web: the acceleration of coordination and motivation”. *Industrial Marketing Management*, vol 32, no 7, 553-562.
- Cagliano, R., Caniato, F., Spina, G. (2003). “E-business strategy: how companies are shaping their supply chain through the internet”. *International Journal of Operations and Production Management*, vol 23, no 10, 1142-1162.
- Carbonara, N. (2005). “Information and communication technology and geographical clusters: opportunities and spread”. *Technovation*, vol 25, 213-222.
- Crossman, A., Lee-Kelley, L. (2004). “Trust, commitment and team working: the paradox of virtual organizations”. *Global Networks*, vol 4, 375-390.
- Enright, M. (1995). “Organisation and co-ordination in geographically concentrated industries”, in Raff, D., Lamoreux, N. (eds.) *Coordination and Information Historical Perspectives on the Organisation of Enterprise*, University of Chicago Press, Chicago.
- Eurostat (2002). E-commerce in Europe. Available at <http://europa.eu.int/comm/enterprise/ict/statistics/e-commerce.htm> (2007-03-22)
- Handy, C. (1995). “Trust and virtual organization”, *Harvard Business Review*, May/June, 40-50.

- Hardy C., Phillips N., Lawrence, T. B. (2003). "Resources, Knowledge and Influence: The Organizational Effects of Inter-organizational Collaboration", *Journal of Management Studies* vol 40, no 2, 321-347.
- Holmberg, S.C. (2001), "Taking Syntegrity-4 from Assumption Mode to Reflection Mode", *Systems Research and Behavioural Science*, 18, pp. 127-35.
- Holmqvist, M. (2003) "A Dynamic Model of Intra- and Inter-organizational Learning", *Organizational Studies*, vol 24, no 1, 95-123.
- IDC. (2000). "Adoption of the internet by SMEs in Western Europe".
- Jayaram, J., Vickery, S. K., Droge, C. (2000). "The effects of information system infrastructure and process improvements on supply chain time performance". *International Journal of Physical Distribution and Logistics Management*, vol 30, no 3 / 4, 304-330.
- Kendall, K. E. (1997). "The significance of information systems research on emerging technologies: seven information technologies that promise to improve managerial effectiveness." *Decision Sciences*, vol 28, no 4, 1-29.
- Krumwiede, K. R., Swain, M. R., Stocks, K. D. (2003). "10 Ways e-business can reduce costs". *Strategic Finance*, vol 85, no 1, 24-29.
- Kulkarni, S. P., Heriot, K. C. (1999). "Transaction costs and information costs as determinants of the organizational form: a conceptual synthesis". *American Business Review*, vol 17, no 2, 43.
- Maillat, D., Lecoq, B., Nemeti, F., Pfister, M. (1995). "Technology district and innovation: the case of the Swiss Jura Arc". *Regional Studies* 29, 251-263.
- Malhotra, Y. (2000). "Knowledge Management for e-business performance: advancing information strategy to "internet time"" *Information Strategy: The Executive's Journal*, vol 16, no 4, 5-16.
- Maznevski, M. L., Chudoba, K. M. (2000). "Bridging Space over Time: Global Virtual-team Dynamics and Effectiveness", *Organizational Science*, vol 11, 473-492.
- Mitev, N. N. (1996). "Empowerment, change and information technology: socio-technical design and business process reengineering". *Personnel Review*, vol 25, no 4, 56-63.
- Nyström, C., A. (2006). "Philosophy of Technology – A Foundation for Intranet Design". Dubois, D., M. (ed). *Computing Anticipatory Systems*, 381-387.
- OECD. (1998). OECD Science, Technology and Industry Scoreboard 2001. Available from: <http://www1.oecd.org/publications/e-book/92-2001-04-1-2987/index.htm> (2007-03-22).
- Piore, M., Sabel, C. (1984). *The Second Industrial Divide: Possibilities for Prosperity*, Basic Books, New York.
- Porter, M. (2001). "Strategy and the Internet". *Harvard Business Review (March)*, 63-78.
- Power, D.J. (2004). "The comparative importance of human resource management practices in the context of business to business (B2B) electronic commerce". *Information Technology and People*, vol 17 no 4, 380-406.
- Power, D., Singh, P., (2007). "The e-integration dilemma: The linkages between Internet technology application, trading partner relationships and structural change", *Journal of Operations Management*. Doi: 10.1016/j.jom.2007.01-006.
- Rabinovich, E., Bailey, J. P., Carter, C.R. (2003). "A transaction-efficiency analysis of an Internet retailing supply chain in the music CD industry". *Decision Sciences*, vol 34, no 1, 131-172.
- Rashman, L., Hartley, J. (2002). "Leading and Learning? Knowledge Transfer in the Beacon Council Scheme". *Public Administration*, vol 80, no 3, 523-542.
- Reid, A Catterall, M. (2005). "Invisible data quality issues in a CRM implementation". *Journal of Database Marketing & Customer Strategy Management*, vol 12, no 4, 305-314.

- Sabath, R. E., Fonatanela, J. (2002). "The unfulfilled promise of supply chain collaboration." *Supply Chain Management Review*, 24-29.
- Sanders, N. R. (2007). "An empirical study of the impact of e-business technologies on organizational collaboration and performance". *Journal of Operations Management*. Doi:10-1016/j.jom.2007.01-008.
- Schlosser, A., Kanfer, A. (1998). "Culture clash in Internet marketing: implications for marketing practice", unpublished paper, Vanderbilt university, Nashville, TN.
- Segev, A., Patankar, A., Zhao, J.L. (2003). "e-Business process interleaving: Managerial and technological implications. *Information Systems and eBusiness Management*, vol 1, no 4, 331-352.
- Tetteh, E., Burn, J. (2001). "Global strategies for SME-business: applying the SMALL framework". *Logistics Information Management*, vol 14, no 1/2, 171-180.
- Vescovi, T. (1998). "Literature, metaphors, and the formula to advertise in the Internet", in Kitchen, PJ (ed), *The changing world of Corporate and Marketing Communications: Towards the Next Millennium*, BGS, Glasgow.
- Vescovi, T. (2000). "Internet communication: the Italian SME case". *Corporate Communication: An International Journal*, vol 5, no 2, 107-112.
- Wong, K., Y., Aspinwall, E. (2005). "An empirical study of the important factors for knowledge-management adoption in the SME sector", *Journal of knowledge management*, vol 9, no 3, 64-82.
- Zakaria, N., Amelinckx, A., Wilemon, D. (2004). "Working Together Apart? Building a Knowledge-Sharing Culture for Global Virtual Teams". *Creativity and Innovation Management*. vol 13, 15-29.

There and Back Again – Inquires into the Development of a Viable Organizational Participatory Design Ability

Johan Bolmsten

The World Maritime University Malmö, Sweden

jb@wmu.se

Abstract. The World Maritime University is a multicultural organization where professionals, both academic and non academic, from virtually all over the world come together in the pursuit to improve and spread knowledge about maritime affairs. With organizationally and geographically diverse activities, software that works to support and improve work processes and to collaborate and exchange information is considered of key importance. This paper is based on the experiences of the Faculty IT Specialist during and in between two development projects. By rising above the individual project level, it is described how the nature of participation can change to maintain a viable organizational Participatory Design ability. In addition to providing insights into the area, a main idea is to investigate ideas for future research.

Keywords. Participatory Design, Organization

1. Introduction

It can be assured that staff on all levels of the World Maritime University (WMU) organization are highly knowledgeable about their working domains and, given the right opportunities, can have many ideas on how to improve things in terms of software support. Taking advantage of stakeholders' competencies and gaining their

acceptance and understanding for developed applications is of importance in order to cope with the heterogeneous and complex organization that WMU presents. From a Participatory Design (PD) standpoint, the idea that the knowledge needed to design and implement interactive computer-based systems is best developed through active cooperation between workers and designers – in order to achieve the best fit between technology and the way people work – is well known. That various stakeholders can have different perspectives which may influence their interpretation of a domain is a fundamental principle. This, together with the following common PD assumptions, fits well when describing the WMU environment:

1. Workers are intelligent, creative, and productive contributors to organizations if they are empowered to express their expertise, exercise their decision making capabilities and given responsibility for the impact of their decision making.
2. PD holds that, contrary to a Tayloristic belief, good ideas are as likely (perhaps even more) to come from the bottom up as from the top down. Front-line workers know what works, and have a lot of ideas of how to improve things. (Miller, 1993).

This implies a strong focus on quality- and use when it comes to usability and usefulness of the software designed as opposed to the product focus of control oriented software engineering (Floyd, 1992 p. and Floyd, 1989).

By adding a new Faculty IT Specialist to its staff list in the beginning of 2005, the university sought to revive and enhance the software support given to faculty, staff, and students. The main tasks of the position were formulated as to develop both existing and new applications. A long term goal was also to work more actively with integration and usage in the organizational context.

This paper describes how the spaces for interaction at WMU have evolved during a transformation of the faculty software development activities. By rising above the individual project level, it is described how the nature of participation can change to better accommodate a complex and evolving organizational reality. Through presenting two development projects and contextualizing them within the overall organizational environment, the value of being able to re-orient the area of participation in the organization is put in focus. The overall research question that has guided the empirical work is: How is it possible to continuously be able to provide a viable organizational PD ability?

A main idea of elaborating on and around this questioning has been to identify interesting areas for future research. The WMU organization does, arguably, present an environment that can provide interesting perspectives and insights to this end.

The motivation for the article was realized when looking for PD material to help to guide the above change process. It was surprising how scarce newly produced PD research was that described working PD in the organizational arena. That PD can be characterized by isolated projects, which was noted by Clement and Besselaar in 1993, still, in-large, seems to be a valid point. Maybe an explanation to this state can be found in Kensing and Blomberg's (1998) observation that PD projects have,

during the last 20 years, *somewhat focused* on the individual project arena where specific systems are designed. Emphasis has been put on how to foster a “direct and unmediated partnership between designers and the users of systems” (Shapiro, 1994, p. 425 cited by Gartner and Wagner, 1996). There are interesting exceptions where the researchers have observed and helped to improve an established practice; two of these are Dittich, Eriksen, and Hanson (2002) and Dittrich and Lindberg (2002). Both of these articles have served as an inspiration for the research conducted here. Overall the author is, however, prone to agree with the former researchers when they argue that a main challenge for PD researchers is to deal with the broader organizational arena “on which PD initiatives depend for their long-term survival”.

2. Method

The title of this paper paraphrases a famous travel book and denotes the process and way of conduct underpinning the empirical research carried out. This paper is based on research from “within”, it takes its stance in the working experiences of the Faculty IT Specialist during his time at the university. From the authors’ working day as developer in local projects at the faculty, it is described how he embarks on an adventure outside the scope of his normal activities to participate in the organizational transformation of the development activities. After the “battle is won” the Faculty IT Specialist returns back to his safe normal haven. In other words: “there and back again”. In addition to the prior outlined PD assumptions, the empirical research in this article is influenced by the dynamics that were realized by Lehman already in 1980: The introduction of a software system in an application area changes the very same area and the perceptions of the problems for which the system was originally introduced. In a sense, the program has become part of, and is embedded in, the world it models. From a participatory standpoint, software development can be recognized as not starting from predefined problems; but instead, development is viewed as a continuous and cooperative evolutionary process. This is a learning process that involves both the unfolding of the problems, as well as the elaboration of a solution (Floyd, 1992). In line with the “shopfloor” perspective presented by Dittich, Eriksen, and Hanson (2002), the idea, from a research point of view, is to understand and account for the activities of the organization and participate in the continuous development of working software development practices. The principles of “Co-operative Method Development” (CMD) developed by Dittrich et al (2007), are used to provide a basic structure to the research:

- 1 Understanding practice
- 2 Deliberate Improvements

3 Implement and Observe Improvements

CMD is based on a qualitative research approach where academic theories are used, in the first instance, as an input to improve the practical work processes of the organization. General applicable research is then based on participatory observation and reflection together with analysis in grounded theory. The empirical findings, here, were documented through research diaries, semi-structured interviews, studies of various manuals and programming code, and informal work shops where techniques and tools were discussed. In the following sections a broad account is given of the development projects. This should not be interpreted as “unscientific storytelling” (Dittrich and Lindberg, 2002). By making the development process visible and accounting for the researcher’s perspective, it is possible for the reader to better assess the work conducted and also argue the conclusions. Given the embedded characteristics of the empirical research this can be considered of extra importance.

3. The World Maritime University

350 full time students from about 70 different nations pass through the corridors of the World Maritime University (WMU) every second year. The university provides maritime education, training and research and the students participate in one of eight different Master of Science programs focusing on:

- Maritime Safety and Security
- Protection of the Marine Environment
- Efficiency of Maritime Transportation

WMU was established in 1983 by the United Nations in collaboration with the Swedish Government. “In furtherance of the purposes and objectives of the International Maritime Organization (IMO)” the aim is to promote the development of global standards within these areas as well as to facilitate “capacity building” in, and the transfer of technology to, developing countries. With its diverse set of students and its staff body of 50 resident staff members, from 15 countries, there is no dominating culture at WMU. In addition, the teaching staff is complemented by around 100 visiting professors, from various institutions around the world who continuously visit the university and share their expertise within their different areas. The main base of the university is in Malmö, Sweden. Two local campuses are located in Dalian and Shanghai, China and a considerable part of the universities’ activities takes place at various local sites.

4. The development of the faculty software organization

With his enthusiasm and expectations for the possibilities of technology to improve and transform organizational activities, the Vice President (Academic), SM, had a vision of an intranet to enhance the software support given to the faculty of WMU. In addition to basic applications such as wordprocessing, spreadsheets, and mail programs, the idea was to improve staff and student communication as well as facilitate work processes within the faculty. Long-term, a goal was also to create a solution that could be shared with other universities.

4.1 The creation of the intranet

In addition to his other work responsibilities as Vice-President in charge of academic activities, the intranet was a prioritized project. Using his experience from both the shipping industry and the academic environment, SM assessed that, at the time, there was no “out of the box” solution that sufficiently met the required specifications

Together with the then Faculty IT Assistant, DL, it was decided that the best suited solution was an in-house developed web-based intranet. In-house development was considered to facilitate the development process by providing freedom for SM to guide functionality according to the specific requirements of the organization. Following SM’s ideas, DL was, to a great extent, given a free hand to design the intranet. DL was a dedicated programmer, and the model of development chosen was ultimately made possible through his technical know-how and programming skills. The emphasis for the first development cycle was to establish a fundamental structure, including choosing and implementing an overall programming model together with routines for security, etc. Also, basic functionality such as file management and news items were developed. The result was a coherent product that, as intended, gave basic software support to the members of the faculty. With the success of the first version, the next step became to develop a more adapted functionality, and when DL decided to leave WMU, basic organizational-specific functionality for both subject management and mark management existed.

4.2 A changing agenda

By the time somebody new was appointed - that could continue the development of the intranet - the list of projects to be fulfilled had continued to grow. The value of having an intranet and the potential of developing both existing functionality as well as ideas about new functionality had been realized more and more. This especially concerned interactive functionality that would closely tie-in with and improve upon

work processes for the faculty. A prioritized project was to develop a schedule component that would complement and extend already existing functionality. It was a comprehensive project that, virtually, involved all of the already developed code. As almost no documentation existed, it also became a learning vehicle for the new Faculty IT Specialist, JB, to understand the programming model in place and the already developed functionality.

4.3 The schedule project

A clear picture existed of what type of functionality the new schedule component needed to include. SM's idea was to create a central location for all information relating to courses; information that, at the time, was scattered throughout the intranet and in other systems throughout the organization (both manual and electronic). The schedule had to be compiled from these different sources and was then published in spreadsheet files. A consequence became that the scheduling process solely relied on - and, in essence, became locked to - one of the Faculty Assistants. And concerning making the schedule easily available, staff and students were dependent upon it being uploaded on the intranet as well as printouts being made available on bulletin boards throughout the university. There was, at the time, no opportunity for users to directly extract their personal schedule and it was difficult to communicate changes.

During the development process, the close collaboration that existed between SM and DL continued with JB. With closely situated offices and an informal management style, there was a lot of room for interaction. Although the scope and structure of the project, for the most part, was already specified, frequent formal and informal meetings and discussions took place about the specifics of different aspects of the functionality. In total, it took around one year to finalize and launch the first version of the schedule component. During this time, a basic understanding had also been gained about both the application itself and the application's environment from JB's point of view. The new functionality was introduced through both individual and group training sessions. However, although the new schedule component had a clear mandate from SM and arguably was viable from a programming perspective, it was already apparent soon after the introduction that the new functionality was underutilized. When analyzing statistics from available log files and doing follow up studies of how the application was used, it turned out that it was not adopted to a satisfactory extent. Two examples can be given that were both derived from how the staff experienced the functionality (members of staff were considered key users as their information input and usage affects the adoption of the application in a broader context):

- *Considering the university's relatively small size, a quite extensive teaching/assessment schedule exists. The development of interfaces for creating and coordinating the schedule was, thus, emphasised during the first development cycle. The intention was to make the new component more generic and easily managed as compared to the old solution. This meant opening up the scheduling process to more members of staff. Two new interfaces were created. An "information based" one that was directly tied to the different subjects, where the idea was to create an interface that was fast to work with and that easily supported entering large amounts of assessments. Considerable time was also spent on creating a graphical planning tool, where it was possible to get an overview of the university's activities and easily change and update individual assessments. The reliance on the spreadsheet files did not disappear though. A main objection from the Faculty Assistant in charge of the schedule was that the new solution did not satisfactorily take into account the often chaotic and multi-faced process around the scheduling. It was argued that it was quicker and more flexible to "do the complex puzzle" that the scheduling actually constituted with the spreadsheet program. It was, for example, easier to copy and paste data, and the loading times, especially in the web-based graphical interface, exceeded the ones in the spreadsheet program. As professors usually submitted their schedule as notes in a spreadsheet-based format and also had many change requests, the spreadsheet program interface was easier to work with. Another comment was that although the new schedule component was more generic, it was also more rigid; it did not allow for the many variants of scheduling that were needed. There were many examples when the planning of certain types of assessments required special arrangements and the argument was made that there was more flexibility for this in a spreadsheet format.*
- *Another key user group was the "Teaching Staff". An idea with the new schedule component was to create a "one stop shop" for all course- related work. Information that before had been scattered over multiple systems (both manual and electronic) would be gathered in one place. Opportunities were created for the professors to, for example, easily access information about course participants. The new functionality enabled the professors to extract course lists of the students with photos and detailed information about e.g. which specialization the students belonged to. The new system also allowed professors to connect relevant information such as syllabus and handouts directly to the course. As was the case with entering the schedule, the new functionality to support the staff did not become integral in work activities. Overall, it was difficult to get a good picture as to why the new system was*

not used. It was clear, however, that it was not straight forward for the members of staff on how to integrate the new functionality now available to them into their established ways of working. In addition, there were organizational dependencies and issues that were not accounted for or solved with the new system. There was, for example, a desire, in addition to the teaching schedule, to have a total overview of activities. Thus, many transferred the schedule manually to e.g. graphs on the wall or to the collaboration tool client available in the university, making the new schedule extract capabilities, in large, redundant.

4.4 Taking a new perspective on development

Already, at the time of employment there had been discussions between the Faculty IT Specialist and the Head of Information about the future of the faculty software development. Based on the experience from their respective fields, it was possible to see that the more and more interactive applications that were desired posed challenges to the existent programming platform and model. That changes were pressing was further emphasised by the recent experiences. The schedule component was, from an interactive standpoint, the most comprehensive project so far. In terms of affecting users' ways of working, it gave a taste of what future development projects would entail. A starting point for the discussions was that the current development approach resulted in a technically coherent solution, but was limited when it came to reaching out to the user-community and utilizing their knowledge in the design process. It was considered as a strength to have a internal software development capability closely tied to the faculty, but was believed that more could be done to utilize this capability. It was desirable to maintain the close collaboration with the Vice President (academic), but also to expand the collaboration with the faculty. The arrangement where the Faculty IT Specialist organizationally reported directly to the Vice President (Academic), SM, who provides the strategic guidelines, was important. However, the tradition established with the introduction of the intranet where the main focus of the position was targeted at programming for a web based intranet system could be reviewed (quite naturally, the programming focus had been emphasised additionally during the development of the schedule component due to that the functionality already was specified and that a lot of backward engineering was needed to gain an understanding of the existing application). During this time, the university were also undergoing an expansion of its activities. In addition to the Swedish campus, campuses were opened in Dalian and Shanghai. Also, doctoral programs were started. These developments meant additional work for existing staff,

thus further emphasising the importance of streamlining faculty work. A number of efforts for change were initiated:

- IT-Group: In addition to the Faculty IT Specialist, the IT-Group consisted of the Head of Information, the Network Specialist, and the Program Officer. The group was a newly instated effort by the Head of Information to bring the main IT related competencies together in an informal way in order to broadly explore and reflect on how to maintain and develop the IT environment at WMU. In the group, technical and information management aspects were discussed. *How could, for example, the basic application support and network environment present at WMU best be utilized and built upon (Network Specialist)? What were the main requirements from the rest of the organization in terms of information support and how could this information be organized (Head of Information and Program Officer)?*
- Discussions with SM: The open and informal discussions and meetings with SM continued. *What were the academic visions for the future faculty IT support? How could they be intertwined with changes to the software development? How could improvements be utilized and what may have to be given up? Could, for example, the vision of a “boxed solution” possibly to be provided to other universities be abandoned?*
- Meetings with faculty staff: Together with SM, meetings were arranged with the Faculty Assistants. Their feedback was considered important as they have key roles in supporting the teaching staff in their activities. The meetings gave SM an opportunity to present his ideas on the faculty IT support, and at the same time gave the Faculty Assistants an opportunity to communicate their perspectives on their work. *What were the challenges in giving the professional staff IT support? How could this support be improved? What other organizational measures had to be taken for this to work?*

In relation to the meetings, a number of reflection papers were produced by JB. They were an effort to create a foundation for the discussions and to investigate and outline different possibilities from a software development perspective. Effectively, they became evolving and working objects that provided transparency to the different stakeholders throughout the investigation process and a base for decisions.

The main point was that stakeholders had to be involved more actively in the development process. Two main metaphors were commonly used throughout the discussions: with inspiration from the paper “PD in the wild” (Dittich, Eriksen, and Hanson, 2002) the concept of “the designers, that’s us” was introduced during a meeting to initiate a discussion with the Faculty Assistants of the importance of utilizing their knowledge. It was picked up and became a way to explore how it was possible to collaborate during the development process. Another idea was the

importance to avoid “reinventing the wheel”. By emphasising this, it was possible to visualize that resources were limited and the importance of making the most of them. Realistic expectations had to be created about what technology could achieve.

A couple of main change areas were identified: a new software development platform and programming model was needed, and improvements to the project management had to be made. Although both areas were identified as important, their implementation was prioritized according to organizational realities and their level of maturity. It was assessed that the key change area was to find a new software development platform and programming model. The existing programming model gave considerable programming freedom. It was a stable and effective structure that, for example, made it easy to reuse code. However, it was difficult to involve stakeholders in the development process. The model was optimal for programming not for collaboration over functional boundaries. The development platform used, also, basically tied the development to the web.

4.5 Implementing a new development model and programming platform

Several new alternatives were considered. The challenge was to find a solution that both could encompass existent functionality - it was considered of importance to maintain and be able to develop already existent functionality - and be able to face new challenges, as developing more complex and interactive applications. With the solution chosen, the programming model gradually evolved, not radically transformed. It was turned into a more distinct multi-tier and component based architecture. A design that, among other things, made it possible to reach out into new program environments (see Figure 1)

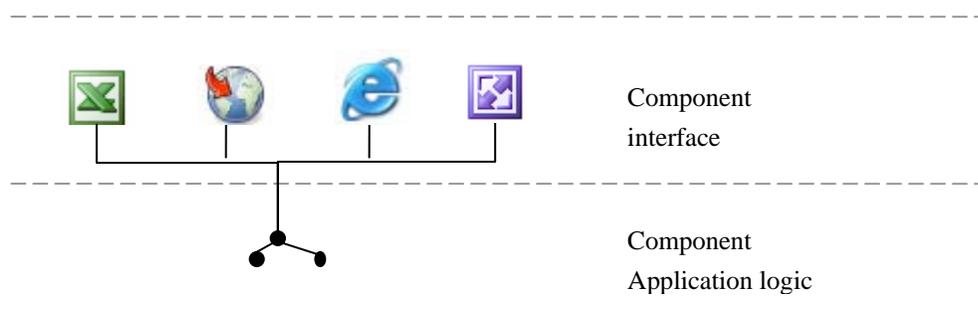


Figure 1

It also became possible to work more easily with prototypes and shorter development cycles. This made it possible to work closer with various stakeholders and, thus,

facilitated collaboration during the development process. During the implementation of the new development platform and programming model, a number of small development projects were carried out. The intention was both to test and explore the capabilities of the new environment and to enhance existent features. Examples of these are:

- Spreadsheet program: After thorough discussions, it was recognized that there was a valid purpose in doing a working copy of the schedule in spreadsheet format. An interface was created to enable import of the spreadsheet draft to the intranet.
- Email and collaboration program: The email and collaboration program was a tool that many staff members already knew and appreciated. An interface was created to export subject and schedule information to this client. This not only made the schedule more accessible, but also enabled a gathered view with other appointments.

The new development model and programming platform not only made it possible to benefit from the functionality in other applications it also made a rich flora of functional libraries available; freeing up more time to interact with users.

4.6 The forms project

An example of how the new environment has been utilized is the development of an application to improve the handling of forms. The project involved taking an overall stance at the usage of forms throughout the organization and coming up with ways of how they could be improved. Forms are important in many business processes throughout the university. They are an often well integrated component to communicate and document decisions, and regularly cut across departmental boundaries. In order to design a viable solution, it was therefore important to, already from the beginning, get support and work actively with stakeholders from different departments throughout the organization. To accommodate this, a number of forms were selected for the first development cycle: “Change of Grade form”, “Travel Application form”, “Professional Development Course form”, and “Library Reference form”. This involved collaboration with members from the faculty, administration, registry, and library. The solution that was chosen involved creating electronic forms in a program included in the office suite available at the university for this purpose. With this approach, the forms came to share the same look and feel as other programs in the office family, making it possible to utilize the staffs’ already existing knowledge of those programs. This made it easier to visualize and communicate the development process, as well as for staff to integrate and make sense of new functionality in their existent ways of working.

Currently, members from administration, owner of most of the forms, and library services are receiving training in how to set up their own forms. The training sessions have the nature of hands-on informal workshops where a member of IT Services assists a staff member at a work-station to explore the possibilities of a new form design within their specific work settings. This collaboration also becomes a learning vehicle to explore the possibilities of how this new technology best can be used. With the adopted approach, ownership is retained by the staff members that have the best understanding of the complex reality that often surrounds the forms. Competence is also built up to enable staff members to adopt the forms to changing organizational requirements.

Given the office based character of the form, future updates of the interface can be carried out by users, with administrative rights, thus, making it easy to change the form without necessarily involving IT-services. Even though IT Services are closely involved during the design of the first form, the model that is adopted for the development of future forms involves, to a great extent, letting organizational members design their own forms. IT Services will mainly be responsible for giving basic education on how to develop forms as well as providing support for connecting them to relevant backend services.

5. Discussion

A decision that has been honored throughout the history of the faculty software development is to maintain an internal software development capability. As stated in the prior section, this decision is based on the special characteristics of the university's activities. The question has been: what should be the aim of this capability and how can it best be utilized?

5.1 An evolving area of participation

Promoting knowledge-exchange and collaboration, and overcoming cultural boundaries is part of the core principles and mission of WMU. From this article's point of view, it is interesting to note the differences in participation before and after the changes in development platform and programming model were initiated. It is also interesting to highlight the value of being able to re-negotiate the area of participation.

A basic observation is that the faculty software development has continuously been based on close and, in many respects, informal participation. The original development approach, with the close collaboration between SM and the Faculty IT

Specialist had primacy over such products as program texts, user documentation and additional documentation such as specifications. A mutual competency base was built up between the Vice President (Academic), SM, and the Faculty IT Specialist, JB that could be used to explain how the solution related to “affairs of the world that it helped to handle” (Naur, 1985). With this understanding it was possible - from their perspective - to respond constructively to demands for modifications of the program to support the affairs of the world in a new manner. Due to increasingly more interactive development projects involving more stakeholders, the once effective development approach was, however, challenged. As the development, in many respects, was confined to the JB and SM - and the resulting solution was implemented throughout the organizational hierarchy through a strong mandate from SM using appropriate measures e.g. training - the problems of the perspective that the original intranet came to impose on the application domain became accentuated. In addition, the distinct web-based development platform and its effective but programming focused programming model helped to make the intranet into a coherent but separated product to the rest of the organization. Nygaard (1986) uses Bråten’s (1973) definition of model monopoly to discuss perspective power. He states that it is possible exercise perspective power and establish a perspective monopoly by insisting upon, and succeeding in the exclusive use (in the development process) of facts, experience, concepts, techniques, and tools that are meaningful within the framework of a system perspective. Intentional or not, it can be argued that this was what the original development process did. Due to a strong user community that understood the diversity and complexity of their working environment, the success of this approach was, however, limited.

From the Faculty Assistant’s point of view, in charge of the schedule, a spreadsheet and calculation program hardly constitutes an optimized tool for scheduling. Having worked with this tool actively for a long time, he had, however, learnt to utilize its strengths, and at the same time invent ways to circumvent its weaknesses. By the time of its introduction, the new schedule component was not an optimal tool either. The development and implementation processes did, however, not create satisfactory opportunities for a successful evolvement of the tool. Turning to the form project: as was the case with the schedule component, the project also entails a quite radical transformation of the organizational activities. But opposed to the former project, a starting point was to expand the area of participation in order to utilize the staffs’ already existent competence and facilitate for active collaboration. If one will, the solution became an active part of the “cognitive universe” (Nygaard, 1986) held by the faculty staff. Where the schedule component failed to become an integral part in peoples’ ways of work, the forms application succeeded due to the altered development techniques and focus.

5.2 Re-negotiating the spaces for participation

The events that were initiated after the schedule component development project were an effort to take a broad stance of how the Faculty Software development capabilities could be better utilized in the organization. This process can be described using, for example, the multidimensional learning spiral framework, proposed by Nonaka and Takeuchi (1998), that visualizes how individual learning is amplified and moves up and down through expanding communities of interaction, resulting in organizational learning. Through the IT Group, the continuous open discussions with SM, and the meetings with the faculty support staff it was possible for the different organizational actors to step outside their immediate working context. This enabled an exploration of both the realities and possibilities for enhancements of the faculty software development activities. The PD nature of the development activities was explicitly identified and elaborated on; resulting in that participation and collaboration over functional boundaries was continuously prioritized. Also, more could be done to make the most of the IT capabilities that existed in the organization to meet the challenges of current and future software development ventures. A more pluralistic view on the organizational units and its participants and interactions was needed. It was decided that the first major action in transforming the software development capability was the migration to the new software development platform and programming model. Back at the local project level, this in itself this opened up for “new realm[s] of thinking” (Keil-Slawik, 1989) by enabling the reaching out into new environments, where it is easier to meet various stakeholders. In the form project the updated development approach opened up the development process to allow for a broader range of perspectives and interactions during the design of applications.

Overall, research is lacking within the PD community that distinguishes criteria or guidelines for a participatory process on the organizational arena. Better and more integrated models to systematically describe and evaluate the process of how individuals assimilate knowledge and how that knowledge travels through the organization from a PD perspective. Here, the value has been shown of having a continuous loop of interaction where experiences on the project level find their way to the organizational management level and then back again. To this end, PD could be fruitfully complemented by e.g. organizational learning theories to describe how the individual project can interact with a broader organizational arena. With an extended empirical material this analysis could certainly have been extended at WMU to get ideas into how the faculty software development could continue evolve.

5.3 The importance of PD in the organization

In the form project, JB (Faculty IT Specialist, Sweden), SM (Vice President, China), TN (Professor, Japan), RP (Lecturer, India), DW (Senior Registry Assistant, USA), PN (Senior Administrative Assistant, United Kingdom), and SWE (Assistant Librarian, Kenya) participated. In addition to representing different organizational roles, they also represent different nationalities and different cultural identities. A basic hypothesis is that the underlying values of PD become even more important in this kind of setting.

It could be tempting to apply control oriented software engineering – where effectiveness criteria stems from control over the environment - to bring order to this kind of diverse and heterogeneous environment. Using engineering principles, the technical development is consciously and purposefully planned, often far in advance to the specific decision to which it applies. This planning is predominately at the responsibility of senior management, and is implemented through e.g. maturity levels, spanning long time horizons, along which technical quality criteria can be defined and measured.

The problem with detailed and comprehensive plans in this kind of environment is, however, that it tends to enforce one perspective, one interpretation of the application domain. Especially in a design context as the one characterized here, this appears problematic as it gives a too general and vague understanding quality- and use. In PD, the acceptance of bounded rationality, a pluralistic view on the organizational units and its participants and interactions are inherent characteristics. From a participatory standpoint, software development can be recognized as not starting from predefined problems. Instead, development is viewed as a continuous and cooperative evolutionary process. Focus is put on the collaboration between users and developers, which result in the emergence of insights into the functionality and potential use of the intended software solution (Floyd, 1992). Through this process, it becomes possible to acknowledge and account for different stakeholders perspectives; perspectives which in turn influence the interpretation of the application domain.

The same values that make PD attractive in a heterogeneous setting also, however, pose challenges. PD, by nature, relies on “participation”. There will always be differences in the interpretation of this concept between different stakeholders in the organization. A manager may, for example, have a different idea and different authority than a front-line worker, whose formal mandate is based, to a greater extent, on influence given hers/his expertise. If these differences are apparent even in a culturally homogeneous environment what happens when somebody from Sweden collaborates with somebody from the United States, or Kenya, or France, or Iran. PD cannot base itself on predefined templates or rigorous strategy documents, the design

process and how participation is carried out must by nature depend on the local project setting. How is it then possible for PD to work in this kind of setting whilst staying true to its core principles (what are the core principles today)?

This article has given some initial insights into this area. There is also emergent research into this domain, see for example Elovaara, Igira, Mörtberg (2006), but it is believed that important contributions can be made.

6. Concluding remarks

This article has shown an organization where PD is an existing and is an important component in the daily development activities. The challenge is to align this capability to best support the evolving activities of the organization. Three contributions have been made:

- It has been shown why the nature and spaces of participation constantly need to be renegotiated. In the context of this article, more interactive software posted new requirements on the development organization
- An overall discussion has been provided on how this transformation process was embarked upon. A main idea is that the success is dependant on it being possible to step outside the immediate individual project context, prevent defensive reasoning and promote free and open inquires about the design process.
- Thirdly, both the value and challenges of working with PD in a heterogeneous environment has been emphasised; an area that is identified as interesting for future research.

The steps taken in regard to the WMU faculty software development have initiated a transition to a better faculty software development organization. This article has spanned a large area; too large some would say. A main idea has, however, been to put the focus on challenges and help to identify relevant areas of research that will help WMU and other organizations to move towards a sustainable and viable participatory ability.

6. References

Andreu R. and C. Ciborra (1996). Core capabilities and information technology: An organizational learning approach. In Moingeon, B and A. Edmondson (eds). *Organizational learning and competitive advantage*. Sage, London.

Bråten, Stein (1973): 'Model Monopoly and Communication.' *Acta Sociologica* 16 (2).

- Chakravarthy, B.S. and Y. Doz (1992). Strategy process research: Focusing on corporate self-renewal. *Strategic Management Journal* 13(1), 5-14.
- Clement Andrew and Van den Besselaar Peter (1993): A retrospective look at PD projects Communications of the ACM, Proquest, vol: 36 issue: 6 pages: 38
- Dittrich, Yvonne, Eriksén, Sara, and Hansson, Christina (2002) 'Participatory Design in the Wild; Evolving Practices for Design in Use.' Submitted to the PDC, Malmö, Sweden.
- Dittrich, Yvonne and Olle Lindberg (2002). "How Use Oriented Development Can Take Place: Organizing Software Development to for User-Developer Co-operation". Ronneby, Sweden
- Dittrich, Yvonne, Rönkkö Kari, Jeanette Eriksson, Hansson Christina, Lindberg Olle (2007); Co-operative Method Development Combining qualitative empirical research with process improvement. Submitted to Empirical software engineering journal.
- Elovaara, Igira, Mörtberg, 2006, "Whose Participation? Whose Knowledge: Exploring PD in Tanzania-Zanzibar and Sweden". Proceedings Participatory Design Conference, Aug 2006, Trento Italy
- Floyd, Christiane (1992): 'Software Development as Reality Construction' in: Christiane Floyd, Heinz Züllighoven, Reinhard Budde, Reinhard Keil-Slawik (eds.): Software Development and Reality Construction. Springer Verlag: Berlin.
- C. Floyd, F.M. Reisin, G. Schmidt, STEPS to software development with users, in: G. Ghezzi, J.A. McDermid (Eds.), Proceedings of the ESEC '89, Springer, Berlin, 1989, pp. 48-64.
- Gartner, Johannes ; Wagner, Ina (1996): Mapping Actors and Agendas: Political Frameworks of Systems Design and Participation. Human-Computer Interaction, *Lawrence Erlbaum Associates*, vol: 11 issue: 3 pages: 187-215
- Keil-Slawik, Reinhard (1992): "Artifacts in Software Design." In: Christiane Floyd, Heinz Züllighoven, Reinhard Budde, Reinhard Keil-Slawik (eds): *Software Development and Reality Construction*. Springer Verlag: Berlin
- Kensing, Finn ; Blomberg, Jeanette (1998): Participatory Design: Issues and Concerns. Computer Supported Cooperative Work (CSCW), Kluwer. vol: 7 issue: 3-4 pages: 167-185
- Lehman, Meir M: "Programs, Life Cycles, and Laws of Software Evolution." In: Proceedings of the IEEE 68(1980), 1060-1076.
- Miller Steven E (1993): From system design to democracy. Communications of the ACM, Proquest, vol: 36 issue: 6 pages: 38

Bolmsten: There and back again

Naur, Peter "Programming as Theory Building" *Microprocessing and Microprogramming*, 1985.

Nonaka, Ikujiro and Hirotaka Takeuchi (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation*. Oxford University Press Inc, New York.

Nygaard, Kristen (1986): 'Program Development as a Social Activity.' In: H.J. Kugler (eds.): *Information Processing 86*. IFIP 189-198.

Changing large-scale collaborative spaces: strategies and challenges

Torstein Hjelle and Gasparas Jarulaitis
Department of Computer and Information Science
Norwegian University of Science and Technology
Trondheim, Norway
torstehj@idi.ntnu.no, gasparas@idi.ntnu.no

Abstract. The concept of Common Information Spaces is often used when analyzing cooperative work. Drawing on recent contributions on CIS the paper describes an evaluation of plans and strategies for implementing a new collaboration tool in a large oil and gas company. The new tool is expected to ease information retrieval, improve collaboration as well as improving information quality through change of work practices. Analytically we discuss the drifting nature of large-scale efforts to establish company-wide CIS. We also describe a few uncertainties that we believe are important to consider when creating CIS. Acknowledging that introducing information systems that instigate changes in work practices are inherently difficult within any organization, and even more so in large enterprise organizations, combined with the diversified perspectives on how to establish CIS within the existing literature we discuss how to establish CIS in large contexts.

Keywords. Common Information Spaces, Implementation of large-scale collaborative systems, Oil and gas industry

Introduction

A common information space (CIS) is an important term within the CSCW field of research. It is often useful when analyzing cooperative work. The concept of CIS is valuable when describing and understanding the context of information sharing within a community.

However, CIS has no unambiguous and universal meaning, and is often defined to mean something (more or less slightly) different in different contexts. In this paper we look at different meanings of the term, and evaluate these with regard to the introduction and use of Microsoft SharePoint technology as a collaboration tool within a large international oil and gas company (dubbed OGC¹). The analysis of the situation at OGC is based on internal plans and documents we have been granted access to. We wished to investigate how the introduction of a new collaboration tool was believed to influence the work practices of the users within the organization. Further research will investigate how these assumptions were put into practice.

We draw on acknowledged theory within CSCW to assist in identifying the various characteristics of common information spaces. Using existing literature we evaluate OGC's plans and strategies to gain insights into potential undesired situations that can occur when introducing a new collaboration tool. As indicated by Rolland, Hepsø et al. (2006), there is a need for more research into large-scale common information spaces and we hope to be able to contribute within this area.

The paper is organized as follows: We start off with a brief description of the history of CIS and identify some important contributions in the area. We then look into some possible problems that can arise when introducing new information systems; that is unforeseen consequences, before we investigate the role of plans and strategies when introducing new IS tools. Then an outline of our research approach follows, before we introduce the case in context. Following this is a discussion of the case in contrast to the existing literature before we round off with a brief section describing our future research direction as well as a few concluding remarks.

Theoretical perspectives

Conceptualizing common information spaces

The concept of Common Information Spaces (CIS) was originally formulated by Schmidt and Bannon (1992) to bring focus on an area of "critical importance for the accomplishment of many distributed work activities" (Schmidt and Bannon 1992, p.16) as they believe the area has been neglected within CSCW. They argue that cooperative work is not facilitated merely through access to information in a shared database, but also require a shared understanding of the meaning of this information as the information always has to be interpreted by human actors. A

¹ The name of the company, its products, departments and services described in this paper are pseudonyms.

common information space seeks to explain how people in a distributed setting are able to work cooperatively through access to common organizational information and a shared understanding of the ‘meaning’ of this information. That is, objects and artefacts must be interpreted and assigned meaning. This meaning is situation dependent, and is determined locally within a given context.

Bannon and Bødker (1997) build on this concept and investigate the dialectic nature of CIS. They acknowledge that there are many forms of common information spaces. Sometimes common information spaces are comprised of people working at the same time and place, while other times people collaborate across both time and space boundaries. Though there are various forms of CIS, they recognize that common information spaces have some common identifying properties.

One of the more profound aspects of CIS is, according to Bannon and Bødker (1997), that it has a dialectic nature: Common information spaces are both open and closed at the same time. They are ‘open’, that is malleable and flexible within a local community of practice, and they are ‘closed’, boundary objects to facilitate sharing across contexts and different communities of practice.

Bossen (2002) analyzes CIS in a hospital ward and uses this analysis to identify 7 parameters he argue is useful in order to position a given CIS. The 7 parameters are

1. The degree of distribution
2. The multiplicity of webs of significance
3. The level of required articulation work
4. The multiplicity and intensity of means of communication
5. The web of artefacts
6. Immaterial mechanisms of interaction
7. The need for precision and promptness of interpretation

Using the framework outlined by these parameters, he argues, is beneficial when analyzing a given CIS, and will help provide better knowledge and understanding for cooperative work in a given situation.

Randall (2000) is critical to the idea of commonality within CIS. He argues that it is problematic classifying common information spaces as they range from shared, small groups to complex inter-organizational chains. This is because “we have to deal with issues that arise out of the complex historical and geographically dispersed range of information resources that might be in use in the large organization, or indeed across different organizations” (Randall 2000, p.17).

Rolland et al. (2006) conducted a study of different common information spaces in a major international oil and gas company as well, and their findings suggested some CIS appear to be more situated, momentary and malleable when embedded within an extremely heterogeneous context. They end their paper by acknowledging the “need for more research on large-scale collaborative systems in order to improve current conceptualizations of CIS” (Rolland, Hepsø et al. 2006, p.499). This is because “most studies within CSCW have been focusing on relatively small-scale systems involving a limited group of users collaborating over small distances” (Rolland, Hepsø et al. 2006, p.499).

The role of unforeseeable consequences

An interesting aspect, relating to various implementation or integration activities in organizational contexts is the role of unintended consequences. For instance, Orlikowski (1996) vividly presents how ambitions to implement customer support system in one (small scale) department produced various unintended consequences. Orlikowski (1996) argues that use of technology will not necessarily reflect initial plans, and unintended consequences will pop up from improvisational users actions.

Similarly, Ciborra (2002) argues, that implementation of IS tend to drift from initial plans: “drifting describes a slight, or sometimes significant, shift of the role and function in concrete situations of usage, compared to the planned, pre-defined, and assigned objectives and requirements that the technology is called upon to perform (irrespective of who plans or defines them, whether they are users, sponsors, specialists, vendors, or consultants)” (2002, p.85). While Orlikowski (1996) is mainly concerned with improvisational user act, Ciborra (2002) gives more attention to technological detail and argues for imminence of side-effects.

In a recent contribution Rolland and Monteiro (forthcoming) extend such conceptualizations of unintended consequences and argue that in large-scale contexts unintended consequences are not local phenomenon, quite opposite, they tend to span across complex networks.

Various theoretical conceptualizations, which highlight the role side-effects, drift from plans or unintended consequences, imply that implementation trajectory is hardly controllable or foreseeable. Robey and Boudreay (1999) also contribute to such conceptualizations and argue that technologies do not possess deterministic character, instead they produce contradictory consequences in various contexts.

Strategies as resources

Having outlined a possibility of various unintended consequences in the process of implementing particular technology, we question the role of strategies and plans. Ambitions and strategies to establish large-scale collaborative environments (CIS) are assumed to bring effectiveness and efficiency to organizations. Being aware of unintended and contradictory consequences, we wonder how such strategies work in practice.

The role of strategies and plans in information systems planning, developing or implementation activities can be conceptualized in different ways. The discussion spans from rigid plans, which aim to predict various consequences to more flexible forms of planning, where the notion of exploration has important role. We consider both perspectives important. For instance Ciborra (1994) does not neglect planning as activity, but propose that innovation occur during exploration activities:

"... the strategic application of IT can be the result of tinkering, bricolage, bubbling up of new ideas from the bottom of the organization, or it can be the outcome of and act of quantum innovation, whereby the existing organizational reality, the environment and IT applications are seen in a new light by the members". (Ciborra 1994, p.21)

Another interesting perspective conceptualizing relationship between plans and situated actions is proposed by Suchman (2007). Plans and situated actions are not conceptualized as two confronting concepts, on the contrary they are mutually dependent: "In every case, however, whether constructed entirely in advance or completed and modified during the action's course, the plan is prerequisite to the action" (Suchman 2007, p.53). Important to note that the plan there is not seen as a rigid structure, which determines future outcomes, but as an element in sequence of actions: "... plans are themselves located in the larger context of some ongoing practical activity" (Suchman 2007, p.69). Therefore, plans don't function as intended because actions continually drift, as Latour (2005, p.46) explains that actions are other-taken and dislocated: "... [action] is not a coherent, controlled, well-rounded, and clean-edged affair... Action is borrowed, distributed, suggested, influenced, dominated, betrayed, translated".

Following this conceptualization, strategies or plans, in our case strategy to establish large-scale CIS, are only fragments of ongoing activities embedded in particular time and space dimensions. Therefore, plans and planning activities are not needless as such, on the contrary, plans and planning is necessary in order to make sense of existing situation and mobilize support for change.

Research approach

Reported research leans towards interpretive tradition (Klein and Myers 1999; Walsham 2006), aiming to analyze IS implementation process and surrounding socio-technical contexts. We conceptualize our research design as emergent rather than highly structured. We lean towards inductive approach and identify grounded theory (Orlikowski 1993) and ethnography-informed (Schultze 2000) studies as a relevant approach to explore IS implementation activities in real-world contexts and build our theoretical perspectives on empirical data, rather than analytical constructs. Additionally, we recognize the importance of critical information systems research or so called critical interpretivism, which requires to place studied phenomenon in wider historical and societal contexts and reflexively challenge taken-for-granted assumptions (Doolin and McLeod 2005).

In this paper we present early research findings. Data collection and fieldwork was started in the beginning of 2007. Since then, we participated in one meeting lasting for several hours, with one representative from OGC. We were introduced with the case, main initiatives, existing problems and possible research directions. Besides that, we extensively studied various documents, including project plans, reports, various presentations and other related documentation. Additionally, we had opportunity to study several email discussions related to project planning and execution activities. The content of these documents introduces us with existing socio-technical complexity, main problems stemming from that and main strategic initiatives with expected deliverables.

Having said that, we acknowledge that our knowledge about the case is limited. Extensive fieldwork, in terms of semi-structured interviews and participant observation, has to be carried out in order to capture diverse perspectives and actual actions of various actors. Currently we are in the process of planning fieldwork activities with OGC representatives.

Case description

Introducing new systems for computer supported collaborative work is a complicated task in all organizations as it not only introduces new IT tools, but also new ways of working. What makes this even more difficult in large organizations is that they have so many different people working on so many different tasks at a number of different locations. Introducing one single system to support all users at all tasks in all locations is a major challenge.

In 2001, a major international oil and gas company, that today has about 26 000 employees in 34 countries worldwide, formulated a strategy to improve

collaboration within the organization. This strategy focuses on collaboration within the company, and ranges from so-called collaboration rooms, which are dedicated rooms where experts from various subject areas meet, to systems like video conferencing for collaboration between users at various locations to more traditional collaboration ICT-systems. Collaboration can take place between users at the same or different location, and at the same or different time. People wishing to collaborate at the same time can choose to use the collaboration room if they are all at the same location, or they can use a video conference if they are located at two or more locations. If they want to collaborate at different time – maybe because they are dispersed around the world in different time zones – they can use a more traditional collaboration system.

One of the results of the strategy was the decision to change the collaboration infrastructure. This decision was made in 2003. OGC had up until then been using a system based on Lotus Notes, but after considerable research it was decided to discontinue use of Lotus Notes and instead implement a new infrastructure based on Microsoft SharePoint technology. It was believed that this new infrastructure would better suit the management's envision of collaboration within the organization. In addition, the introduction of this new information system was used to catalyze an organizational change.

Due to the size of the organization, as well as the nature of the business, each month OGC create about 70 000 Word documents, 65 000 Excel spreadsheets, 20 000 PowerPoint presentations and 145 000 non-classified documents. That is about 300 000 new documents each month. Keeping track of all these documents require a robust and scaleable system.

The old Lotus Based collaboration system had a few aspects that were considered unfortunate. First, the Lotus Notes infrastructure had grown out of control. In total the system consisted of more than 5000(!) different, dispersed Arena databases for document storage. Each user had in addition access to both personal and departmental storage areas. The Arena databases had no central indexing functionality, meaning that it was impossible to retrieve a document by searching if you did not know which database to search. Not all users chose to store their documents in the Arena databases, but instead chose to store it on either their personal, or the departmental, storage area. This meant that even if it had been possible to search all databases at once, it would not have been successful as not all documents were stored in the databases.

Implementing the Microsoft SharePoint technology was hoped to change the way people worked. The ultimate goal of the implementation was be able to remove the personal and departmental storage areas totally, “forcing” all documents to be

stored within the SharePoint architecture. This would make it possible to maintain a global index, making searching and retrieving information much easier. Of course, not absolutely all documents created would be immediately available in this index. Rough drafts and short notes are not wanted in this index so the creator(s) of the document would have to tag the finished documents to initiate indexing. But nevertheless, all documents should be stored within the SharePoint infrastructure.

In addition to be a repository for storing and retrieving documents, MS SharePoint is also a collaboration tool. It has functionality for checking-in and checking-out documents, for version tracking; it has a web-based discussion boards, as well a structure for organizing various teams and projects. MS SharePoint can also be linked to email-systems and MS Live Messenger (previously MSN Messenger) for instant messaging.

The goals of the strategy can be summarized in three points:

1. Ease retrieval and reuse of information
2. Improve collaboration processes and information exchange
3. Improve the quality of the information within the company

The company acknowledges that introducing the new information system is just a minor part of the strategy. More important is the change of work practices. In one document they emphasize this through the following quote “80% change - 20% IT”.

Discussion: introducing uncertainties

Common space or spaces?

According to OGC’s strategy the company wishes to implement a single, common collaboration tool, namely a system based on Microsoft SharePoint technology. They have developed ‘Best practise’ directives and guidelines for the use of this new system seeking to create a consistent usage of the tool throughout the organization. We can look at the use of Microsoft SharePoint as a CSCW tool from two different angles; either it is believed that the entire OGC organization with all employees, tools and equipment is one huge common information space that everyone is a part of, or that OGC consists of a vast number of smaller common information spaces that all have the new CSCW tool in common.

Suggesting that OGC consists of one single CIS is problematic as it to some extent would imply that all employees have significant aspects of their work in

common. In a large, heterogeneous organization like OGC this is at best doubtful. Exactly how much does a geologist's work have in common with the work of a production engineer? Or what does the IT department have in common with Human Resources?

As this seems difficult it is more reasonable to assume that OGC consists of a vast number of different common information spaces. That is production engineers have one view of the work situation while geologists have a completely different view. The common information spaces at OGC are in many ways similar to the situation in an airport, as described by Fields et al. (2003, p.21). They found that they could "regard the airport not as a CIS but a constellation of overlapping interdependent CISs that are articulated through boundary objects" (Fields, Amaldi et al. 2003, p.21).

Objects or socio-technical arrangements?

Common information spaces can be seen from two different perspectives: Either 1) as a boundary object; or 2) as a socio-technical arrangement. Boundary objects are "entities that are interpreted differently in different communities of practice, yet are stable enough to retain their integrity as objects, thus facilitating working across the boundaries between different communities" (Fields, Amaldi et al. 2003, p.21). That is, boundary objects are both flexible enough to allow local interpretations, as well as rigid enough to be similarly understood in different communities of practice. This way boundary objects can mediate between different communities. From the socio-technical perspective, a "CIS is not simply a boundary object for different communities of practice, but a socio-technical arrangement that only temporarily on specific occasions are practiced in such ways that give a momentary common understanding" (Rolland, Hepsø et al. 2006, p.494). This latter perspective is, Rolland, Hepsø et al. argue, is particularly relevant when introducing CIS across heterogeneous contexts, where "sharing and negotiating common understanding are much more temporary and fluid than the term boundary object suggests" (ibid).

In our context, the Microsoft SharePoint technology can be considered a boundary object, where all users have a similar understanding of what this new tool is, even though they do very different work and uses very different terminology in conducting their daily work. Using the technology, on the other side, can be seen as a socio-technical arrangement where different users interpret and use the technology in different ways in situations. For instance, a user can utilize the same technology in different ways in different projects or at different times.

Flexibility or closure?

As mentioned, Bannon and Bødker (1997) explore the dialectic nature of openness and closure within CIS. The openness refers to the flexibility and malleability of CIS and indicates the desire for flexible and malleable information systems. Of course most users would prefer such a system when producing information as they would not have to make specific adjustments like special formatting or meta-tagging to upload their information into the system. The system would be able to handle anything.

The old Lotus Notes-based system appears to have had a large degree of this freedom. After all, by the end the system consisted of about 5000 different databases. If a given piece of information did not fit into the existing databases one would simply create a new database fitting ones requirements.

But to the management of OGC this solution is not satisfactory. It is inefficient; both with regard to workers having to do the same work again as they can not find documentation of others having already done it, and with regard to storage utilization as the same information is stored more than once.

In the new Microsoft SharePoint based infrastructure users would have a more rigid solution. Information would have to be assigned meta-tags and keywords before they can be uploaded. The benefits of this are not necessarily obvious to the average user, and there is the risk that users simply add more or less meaningless tags and keywords.

Balancing the organizations need for standardized and strict solutions against the users' wish for flexible and open tools we believe is an important area of research that we wish to look deeper into.

Top-down or bottom-up?

There is a long tradition to promote participatory design as a way to reduce the design-use gap (Schuler and Namioka 1993). Such approach represents so called bottom-up pattern and requires active users involvement in various development and maintenance activities. While the benefits of such method are widely recognized, we wonder how effectively it functions in large-scale projects. For instance, in a recent contribution Ellingsen and Monteiro (2006) illustrate how ambition of seamless integration unfolds over the time. Authors present integration activities in large-scale health care contexts and illustrate how ordering activities in one context produce disorder in other contexts. Consequently, they question the appropriateness of participatory design in large-scale contexts: "...truly user-led development is impossible to achieve in large-scale integration

projects. Furthermore, this increases the possibilities for unintended consequences and disorders...” (Ellingsen and Monteiro 2006, p.464). Such conceptualization underscores that unintended consequences are inherent and participatory design techniques will hardly eliminate them. The question then remains to what extent participatory design should be cultivated.

Considering implementation and use of collaborative technologies in OGC, we identify similar tension as well. For instance, with previous collaborative infrastructure (Lotus Notes) local actors had the ability to participate in the constitution and maintenance of their local information spaces. However, new collaborative infrastructure based on MS SharePoint technologies impose quite rigid information classification standards, which reduce local actors ability to modify local spaces according to their needs. Such change illustrates movement from active participation to compliance. Being aware that truly user-led development and maintenance activities in such scale (over 25.000 actors) are hardly possible, we wonder how to balance local needs with company-wide standards.

Heterogeneity or homogeneity?

In theory, the constitution of CIS is quite explicit and clear, it encapsulates both actor-networks (Latour 2005) and human enacted structures (Orlikowski 2000). Interesting and more attention gaining aspect of CIS is heterogeneity. We conceptualize our research context as extremely heterogeneous (Rolland, Hepsø et al. 2006), but for analytical purposes, we do not discuss the whole context as such, we zoom-in and unpack only technological actor – collaborative technologies – MS SharePoint and LotusNotes.

Both technologies are to same extent homogeneous. They cut across organizational boundaries and impose particular pattern of use. However, MS SharePoint technology, as outlined above, is more rigid. Additionally, it is integrative technology, which seamlessly integrates with other MS products. Thus, MS SharePoint can be conceptualized as large-scale homogeneous and integrated monolithic structure.

Drawing on a recent conceptualization on CIS (Rolland, Hepsø et al. 2006) in heterogeneous contexts, we inquire whether working and effective CIS can be achieved with homogeneous technologies. As illustrated by Rolland et al. (2006) arrangements of heterogeneous technologies tend to be more effectively exploited in cross-discipline collaborative environments.

Further research directions

In the previous section we have introduced several uncertainties related to the establishment of large-scale CIS. To some extent these uncertainties are discussed in existing CSCW literature. Interestingly, considering various contributions, which aim to provide implications for better design and use, we face a number of uncertainties. Having discussed few of them in this paper, we wonder how to balance them in practice.

We assume that identified uncertainties are to some extent inherent in large-scale contexts, rather than resolvable. Additionally, ambitions to eliminate particular tension, is rather subjective, because it is difficult or perhaps hardly possible at all to test or evaluate how particular configuration will function later on. As recently outlined by Ellingsen and Monteiro (2006), ordering in one context tend to produce disorder in other contexts. Furthermore, being aware that actions are other-taken (Latour 2005) and as a consequence plans tend to drift in practice (Ciborra 2002), we inquire how to achieve large-scale CIS in global and heterogeneous contexts.

Concluding remarks

Introducing new information systems in large organizations are complex. Introducing collaboration tools that require the users to change their work practices are even more so. In this paper we have identified some potential dangers and pitfalls when doing this by analyzing plans and strategies against existing literature in the field. A further field study will hopefully reveal which of these that have occurred, and to what extent. Getting empirical data will facilitate a more thorough examination of the situation in practice compared to this theoretical evaluation.

Acknowledgments

This research was supported by the AKSIO project financed by the Norwegian Research Council (PETROMAKS, pr.nr. 163365/S30).

References

- Bannon, L. and S. Bødker (1997). Constructing Common Information Spaces. ECSCW '97. Proceedings of the Fifth European Conference on Computer-Supported Cooperative Work, September 1997, Lancaster, UK. J. A. Hughes, W. Prinz, T. Rodden and K. Schmidt. Dordrecht, The Netherlands, Kluwer Academic Publishers: 81-96.
- Bossen, C. (2002). The parameters of common information spaces:: the heterogeneity of cooperative work at a hospital ward. Proceedings of the 2002 ACM conference on Computer supported cooperative work. New Orleans, Louisiana, USA, ACM Press.
- Ciborra, C. (1994). The grassroots of IT and strategy. Strategic information systems: a European perspective. C. Ciborra and T. Jelassi, John Wiley Sons, Inc.: 3-24.
- Ciborra, C. U. (2002). The labyrinths of information : challenging the wisdom of systems. Oxford, Oxford University Press.
- Davenport, T. H. (1998). "Putting the enterprise into the enterprise system." Harvard Business Review **76**(4): 121.
- Doolin, B. and L. McLeod (2005). Towards critical interpretivism in IS research. Handbook of critical information systems research : theory and application. D. Howcroft and E. M. Trauth. Northampton, Mass., E. Elgar Pub.: 245-271.
- Ellingsen, G. and E. Monteiro (2006). "Seamless Integration: Standardisation across Multiple Local Settings." Computer Supported Cooperative Work **V15**(5): 443-466.
- Fields, B., P. Amaldi, et al. (2003). Representing collaborative work: the airport as common information space. Technical Report, Middlesex University, School of Computing Science.
- Klein, H. K. and M. D. Myers (1999). "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems." MIS Quarterly **23**(1): 67.
- Latour, B. (2005). Reassembling the social an introduction to actor-network-theory. Oxford, Oxford University Press.
- Orlikowski, W. J. (1993). "CASE tools as organizational change: Investigating incremental and radical changes in systems development." MIS Quarterly **17**(3): 309.
- Orlikowski, W. J. (1996). "Improvising Organizational Transformation Over Time: A Situated Change Perspective." Information Systems Research **7**(1): 63.
- Orlikowski, W. J. (2000). "Using technology and constituting structures: A practice lens for studying technology in organizations." Organization Science **11**(4): 404.
- Randall, S. (2000). What's Common about Common Information Spaces?. . Workshop on Cooperative Organisation of Common Information Spaces. Technical University of Denmark.
- Robey, D. and M.-C. Boudreau (1999). "Accounting for the Contradictory Organizational Consequences of Information Technology: Theoretical Directions and Methodological Implications." Information Systems Research **10**(2): 167185.
- Rolland, K. H., V. Hepsø, et al. (2006). Conceptualizing common information spaces across heterogeneous contexts: mutable mobiles and side-effects of integration. ACM conference on Computer supported cooperative work, Banff, Canada, ACM Press.
- Rolland, K. H. and E. Monteiro (forthcoming). "The Dynamics of Integrated Information Systems Implementation: Multiplication of Unintended Consequences".
- Schmidt, K. and L. Bannon (1992). "Taking CSCW Seriously: Supporting Articulation Work " CSCW: An International Journal **1**(1-2): 7-40.
- Schuler, D. and A. Namioka (1993). Participatory design principles and practices. Hillsdale, N.J., L. Erlbaum Associates.

- Schultze, U. (2000). "A Confessional Account of an Ethnography about Knowledge Work." MIS Quarterly **24**(1): 3,39.
- Suchman, L. A. (2007). Human-machine reconfigurations : plans and situated actions. Cambridge, Cambridge University Press.
- Walsham, G. (2006). "Doing interpretive research." European Journal of Information Systems **15**(3): 320.

Running changes and re-design in the auto industry: An exploratory study of engineering and knowledge transfer after start of production.

Amanda Wolgast
University West, Sweden
amanda.wolgast@hv.se

Blair E Carlson
SAAB Automobile AB, Sweden
Blair.E.Carlson@se.saab.com

Abstract. This paper presents a process overview for running changes at a car manufacturing company. The focus areas are communication and knowledge transfer during the issue handling processes for running changes. The research is conducted in the form of a participatory case study over an eight week period including 17 interviews. The process for running changes is interesting to study as it concerns engineering work on components after the start of production, which requires an upstream information flow in the organisation quite contrary to traditional R&D workflow. Projects are mainly initiated when quality issues arise from either production or after-market, but may also be a consequence of cost reduction. The results from the study indicate that the communication pattern within the company is very complex. The official issue handling process is quite intricate and does not allow for short lead times, which may provoke employees to take short cuts. This yields an even more complex and obscure process that no one person can grasp, nor control. The learnings from the study will serve as a foundation for further work, which will focus on ways to enhance the company's ability to make use of knowledge and experience from the production environment throughout the organisation.

Keywords. Continuous Development, Knowledge Management, Knowledge transfer, Industrial organisation, Automotive

Introduction

This paper aims to shed some light on how product development is managed subsequent to serial production in the auto industry. The central result is a process map for running changes, which is based on the findings from a participatory case study of work methods and communication related to running changes at production, quality and design departments at a European vehicle manufacturer. The company where the study took place has, although being part of a global corporation, the advantage of having co-located engineering resources who are responsible for product design.

In the auto industry there are basically three reasons for implementing a new product in production: introduction of a new model, model-year changes, and running changes (Pearce 2004). Development work on new models requires a lot of coordination and integration of different subcomponents. Running changes are incremental improvements that are introduced ad hoc to a vehicle that is already in production. Furthermore, they involve considerably less integration and are usually managed as single projects (ibid).

Background

There are a number of models for the product development process that are used within the manufacturing industry as well as taught in the engineering schools. An early model of the main phases of the product development process was established in 1988 by Hayes, Wheelwright and Clark, see figure 1 below (Wheelwright et al. 1992). In order to decrease time-to-market, the sub-processes within the product development process are often performed concurrently (Almgren, 1999).

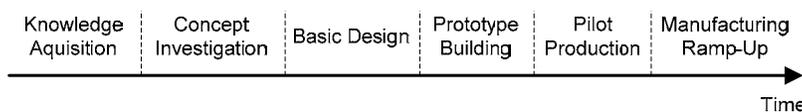


Figure 1. The product development process according to Wheelwright et al. (1992).

Ulrich and Eppinger have a similar view in their generic product development process in figure 2 (Ulrich et al. 2000).



Figure 2. The product development process according to Ulrich et al. (2000).

The early phases including design has been studied extensively, whereas the production ramp-up phase is getting some attention and the prototype building phase has only received little attention to date (Paulin 2006). The purpose of this

paper is to provide some insight of another less researched part of the process, the engineering events that take place after start of production, or ramp-up in figure 1 and 2. These activities include finding issues, resolving issues and finally learning from these issues in order to prevent them from recurring on new models. As functional integration increases, for example with concurrent engineering as mentioned earlier, the sequential view of the product developing process gives way to a more holistic view. From this perspective, it makes sense to include engineering work after start of production, sometimes called current engineering, in the models as a source for important feedback to the development of new products.

This study takes part in research to develop a strategy for strengthening the ability to incorporate production experience into the design phase of upcoming models. Manufacturability affects factory performance on productivity as well as quality. Some quality issues can be directly attributed to the assembly plant, specifically water leaks, loose electrical connections, paint blemishes, sheet metal damage, misaligned exterior and interior parts, and squeaks and rattles. Other issues, like the number of parts that are included in a design or how easy they fit together, have a significant impact on plant productivity (Womack et al. 2007) but are more likely to be attributed to the product development team rather than the assembly plant.

The product development at the company in the case study is organised around a gate process. This means that certain activities must be carried out and certain requirements fulfilled before the project may move on towards the next gate. One purpose of using gates is to coordinate the activities around a timeline and create an effective and visual work flow. There are many gates in a vehicle project, but in general the product development process can be segmented as described in figure 3. This resembles the product development models presented in figures 1 and 2:

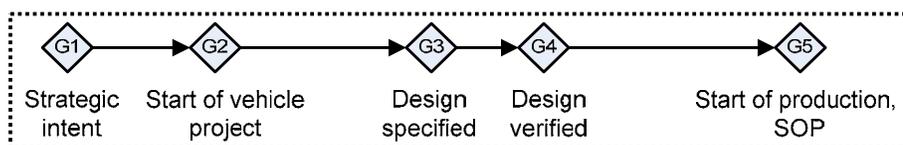


Figure 3. The product development gates.

It is interesting to note that most models stop upon reaching start of production. Subsequent to start of production is current engineering. Current engineering is a part of continuous improvement and continues as long as the product is in production. According to Womack et al (2007) running changes can be introduced in order to increase customer satisfaction, decrease warranty costs, and streamline factory operations. Hence, issues are typically related to warranty, quality or cost saving but they may also be introduced because of legal reasons.

Understanding the procedures for running changes and quality work after the start of production is important for the further work since quality issues are often related to problems in the production and constitute a major proportion of the process feedback that is relevant for improving product development. Figure 4 below presents how learnings from problem solving and other activities in the production could provide process feedback to the product development process during the whole lifetime of each product.

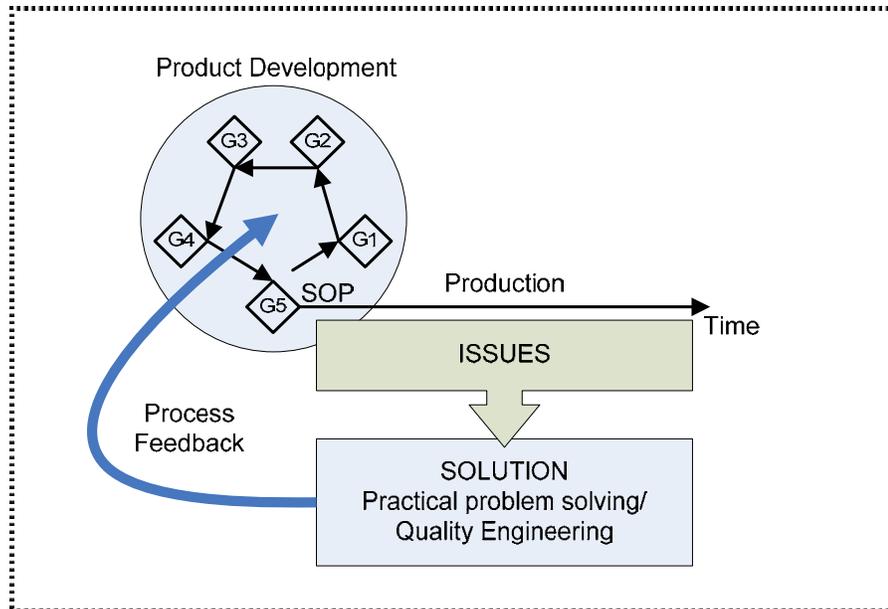


Figure 4. The relation between current production issues and process feedback.

The vehicle manufacturer in the study has a production systems that is based upon principles from the Toyota Production System, TPS, also known as lean manufacturing. Employees are taught problem solving and teamwork, and the TPS method “Practical problem solving” seen in figure 4 is used to solve problems at the assembly line. According to Lean principles, learning should take place by standardizing best practices (Liker, 2004). This implies that process feedback from products in serial production, should consequently be used for updating best practices.

Research method

The study object, running changes, was well suited for a participatory case study. According to Yin (2003) “the case study method allows investigators to retain the holistic and meaningful characteristics of real-life events—such as individual life cycles, organisational relations, and the maturation of industries”. Yin (2003) also states that “The case study’s unique strength is its ability to deal

with a full variety of evidence—documents, artefacts, interviews, and observations”. This current work relies on three types of evidence: documents, interviews and observations. Primary data consists of 17 interviews with key informants and a participatory observation over a period of eight weeks. The goal of the study was to define a process map for running changes. A bottom-up approach was taken, where the observations started in production at an assembly line and continued through quality engineering, design and ultimately the person responsible for best practices for new vehicle projects. This is illustrated in figure 5 where it is shown how the study began with a focus on pure exploration, which over time evolved into interpretation, reflection and finally a tentative synthesis when the full process map began to emerge. Data collection was mainly based on participatory observation, however the interviews became more structured the further from the production line one came. This explains why the findings from departments late in the process are more extensive.

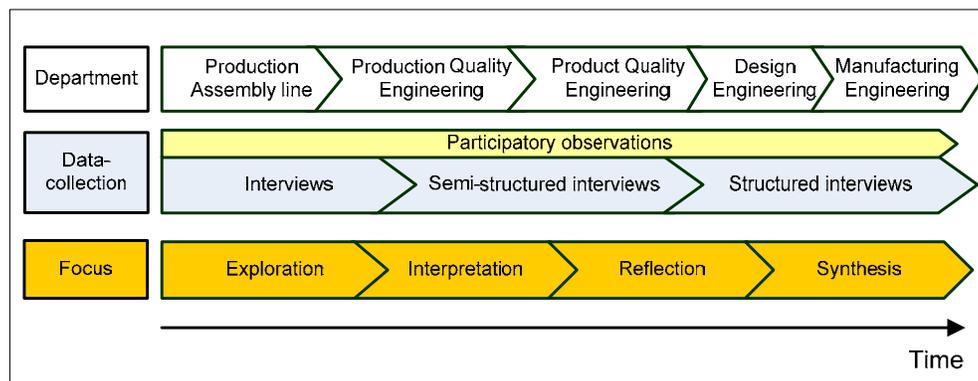


Figure 5. The research process.

The case study aimed to capture as much interaction between groups as possible. Interaction could take place between members of the same department, other departments or extern suppliers. All departments in the case study, as well as the assembly line, handle components for vehicle interior. This made it easier to study the communication as there are a limited number of employees involved. It also made it possible to follow the whole process from start to finish, and find the important interviewees. During the case study, a series of interviews were conducted with middle management and members of their staff. The interviews were quite informal, but focused on a few central themes that were consistent throughout the study. The interviews and other comments or observations were captured by note taking and then entered in a journal where also the impressions were summarised at the end of each day.

Beside direct observations, the employees were asked to show which databases they use and gauge to what extent. They were asked who had entered initial data and also who would receive the new information. The sources of information that was available on paper, shared file areas and some e-mail traffic was documented.

One interesting step in the issue handling process is “handover”, when the issue is transferred to the next instance in the process flow. Compared to new vehicle projects, the current engineering projects need considerably less time from start to finish, why several issues moved to the next department in the process at about the same time as the case study did. This turned out to be a crucial factor for understanding how and how much of the work that had been carried out was actually transferred at handovers. It was noted what information was delivered to the receiving department and what was lost. Key persons were identified during the case study through dialogue with employees, and after the study was finished some interviews took place with some of those in order to complement and verify the material. These persons are not all directly involved with vehicle interior issues like the ones in the case study, but work on a more general level with processes and quality.

The time spent at the assembly line and had a high participatory degree with manual assembly performed in a team. The standard procedure for new employees was followed, and operations were learnt the traditional way by working together with members of the team. Team leader and line area production manager tasks included various meetings with production management and quality follow-ups.

In the production quality department, the researcher took part in the daily work and was mainly involved with attending cross-functional meetings, finding root causes to quality problems and developing temporary solutions, i.e. containments.

The department for product quality engineering belongs to the design department but is placed in the production and work with permanent design changes. This department was important to study because it receives most of its issues from the production and is an important link between design and production.

The design department is mainly focused on new vehicle projects, but have a small group which caters for the more complex current engineering. While studying this group, interviews were also conducted with group leaders for the new vehicle projects and also the person responsible for developing guidelines for design, i.e. best practices.

Result

The organisational departments and work flow

A process map for running changes is presented below in figures 6 and 7 below. Figure 6 presents the basic issue handling process for running changes after start of production, starting with the most common sources of input to the process: the production line areas, after sales, road tests and other sites within the global

corporation. Product related issues that are discovered in the production are first controlled by the component analysis department and then returned to the production line area if the component satisfies the specifications. If not, the issue is handed over to the supplier quality department and follow a process that is not described in this work. The important decision points in the process for running changes is the current product improvement meeting, where issues are escalated to the product change engineers, and the change approval meeting where it is decided whether a change shall go into implementation or not. When decision for implementation is made, the manufacturing engineers and a cross functional implementation team handle the implementation in the factory.

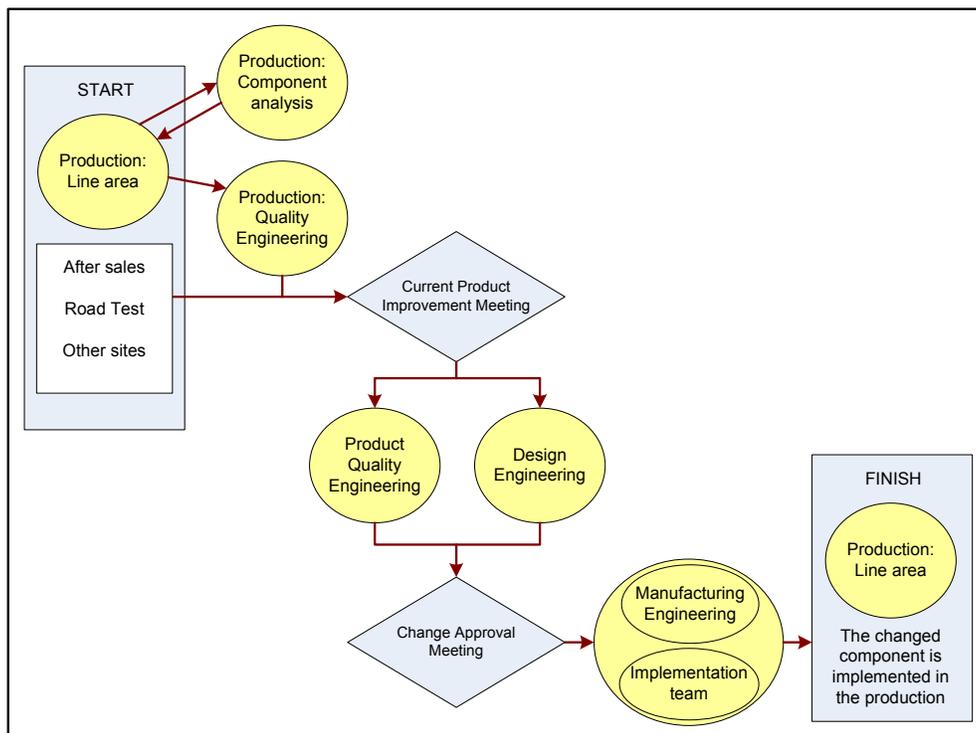


Figure 6. The basic issue handling process for running changes after start of production.

Figure 7 presents how different departments are connected. The solid arrows in the figure point to the next department in the standard issue handling chain and the text on the arrows show what triggers an actual hand over. Dotted arrows in blue show an alternative process based on personal contacts that exists in parallel to the standardised process. The map is somewhat simplified, but encompasses all important steps and departments. The figure is followed by a brief explanation of all the departments involved in the process. The departments that issues mainly are discovered are marked “start” in the figure. Departments that work closely together with suppliers in the problem solving process are marked out as well.

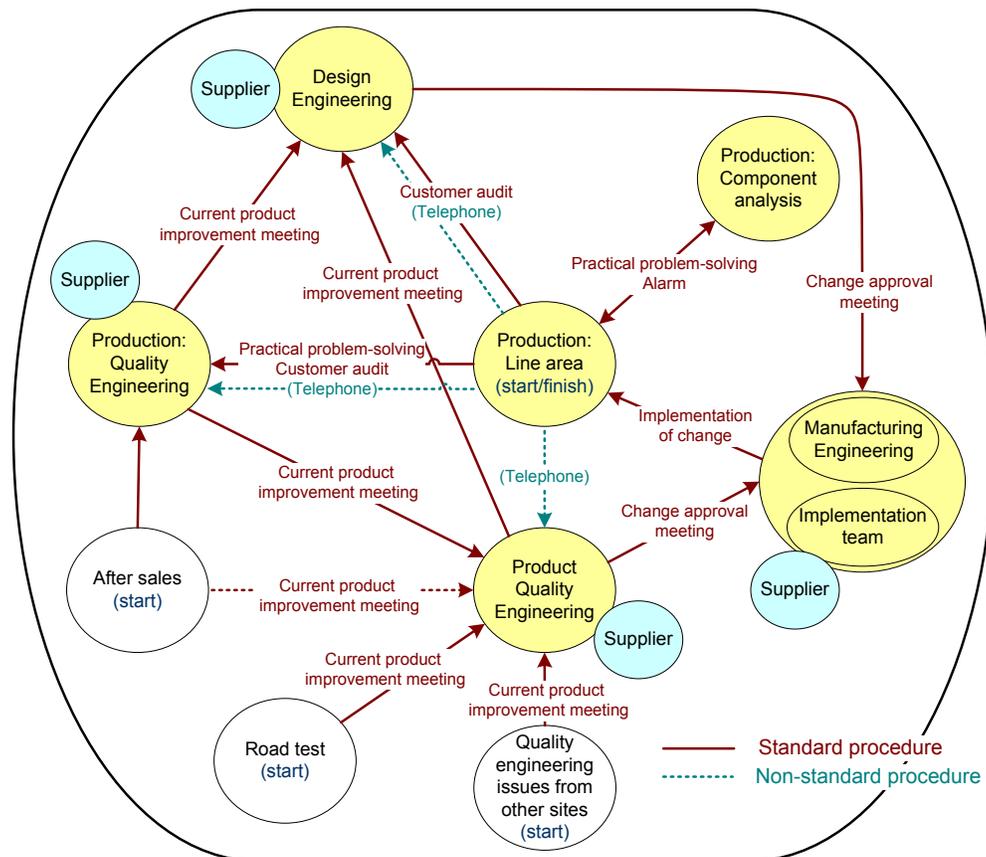


Figure 7. The issue handling process for running changes after start of production.

Production

The production facilities consist of four workshops: press, body, paint and final assembly. The study was concentrated to one of the assembly line areas in the final assembly shop.

Assembly line: Many of the quality issues are first discovered at the assembly line in the factory. According to standard procedure it is the responsibility of team leaders or their line area production manager to start up a case for “practical problem-solving” when a problem has been identified. The practical problem-solving is a tool in TPS for investigating or solving problems where they appear. The procedure is the same for process related problems as well as product related problem. The practical problem-solving is made around a two page-paper form, which works as a tool as well as documentation and a basis for discussion. The form consists of multiple sections. The problem is initially described, located and defined with text and a drawing or photograph. Team members or the receiver of the form make complementary comments. The next section is devoted to quality

where geometrical deviations as well as measures for down time in production due to the problem are noted down. Temporary countermeasures, so called containments, are recorded together with responsible person or instance as well as status and introduction date. When these preparatory steps are completed, the actual problem solving process can begin. With guidance from check-lists the team decides whether the correct process, tools or materials have been used. If not, the team makes corrections and the problem might be solved. If all above seem satisfactory and it is a process related problem, then the issue is often solved together with maintenance and the problem solving form stays at the assembly line. If the problem is product related, the first step is to have the component controlled by the department for component analysis (see below). If the component is correct according to its specifications, the team continues to pursue the root cause of the problem by for instance making an Ishikawa-chart or Pareto-chart. For the most likely cause the teams use the TPS-method "5-Why?". The team leader or line area production manager enters the best solution to the problem implements it if possible. The permanent solution is entered in the practical problem-solving form that also encompasses a lessons learned field where copies of the form are forwarded to those it may concern in the local or global organisation. If the problem cannot be resolved within the line area, the practical problem-solving form is handed over to the production quality engineers.

Customer audit: A certain percentage of the manufactured vehicles are controlled in a so called customer audit. The customer audit team puts together statistics that can initiate an issue process depending on the severity and frequency of the problem. Quality issues on sold vehicles are in contrast usually identified through warranty statistics from after sales.

Component analysis: This department check that components fulfil the specifications. If not, they contact the suppliers and work together with them to find a solution as well as sorting out defect components in production and supply.

Production Quality Engineering: There are three main inputs to the production quality engineering department. The most common is a practical problem-solving form from any of the four workshops. The quality engineers are supposed to go and collect the form directly from the involved team leaders or line area production managers and learn about the problem on location. Another input is the customer audit team which discovers quality deficiencies during routine check-ups. The third input to the production quality engineering is after-sales, where problems are detected mainly by warranty statistics. It is also possible that the quality engineers start an issue process on a problem that they have become aware of through a phone call or contact with other employees in the production. The latter is not a standard procedure and it occurs less and less frequently as the practical problem solving method is becoming the predominant way to handle issues. This department is involved in developing containments

and finding root causes for quality issues. They investigate if the process can be changed in order to permanently solve the problems. If the problem is originating in the product, the engineers escalate issues at a current product improvement meeting where members from different quality departments attend. At the meeting, they appoint a champion for the issue from the product quality engineering department. The production quality engineers start up a new issue in a global problem resolution database for quality engineering. They arrange for hand over to product quality engineering by entering the root-cause of the problem. A “containment authorisation” file is attached if a containment has been developed. The containment authorisation is a one-page document with pictures from photographs or CAD-models prior and subsequent to the introduction of the containment.

Technical Development

The department for technical development include many functions, e.g. new vehicle design, development of design guidelines, current engineering and R&D activities on design, materials, manufacturing, safety and ergonomics, etc.

Product Quality Engineering: The engineers in this department work with design changes on components in current production. Organisationally they belong to the technical development, but physically they are placed in one of the production facilities next to the production quality engineering department. They receive most of their issues from them in the global problem resolution database, but there are also a number of other ways. They can receive an issue from another production site and work out a solution together with their quality engineers. Another way is the road test, where new car models are disassembled after some time on the road. The engineers check that all components in their area of responsibility meet the quality requirements. If they find an issue, they escalate it at the current product improvement meeting and start a project in the global problem resolution database for quality engineering. Product quality engineering can also receive issues from road tests or durability test in a report that is stored as in a preliminary stage in the global problem resolution database. The issues are assessed at the current product improvement meeting where it is decided if an issue should be accepted and consequently managed in the global problem resolution database. A third way is input from after sales, although it is more common that the after sales department contact product quality engineering as a first step. Information from after sales is however widely used in this department as reducing warranty cost is the key target when prioritising among issues. The engineers are sometimes contacted directly by members of the production staff. This is not a standard procedure, but occurs on urgent matters or when the issue is not perceived as being acted upon by production quality engineering. The engineers often make a permanent solution of the containment developed by the production quality engineers. The difference is that the solutions undertake a

thorough validation before being specified as a change in the component drawings. If the suggested root cause turns out to be false or incomplete, the product quality engineer invests the root cause as well.

The engineers have a lot of contact with design engineers from the suppliers, who are often involved in the development of solutions and sometimes prepare prototypes for the testing activities. The quality assurance is connected to a 14 step work process where a lot of documentation is made. The work flow was under development when the study was made, but parts of it had already come in use. When a solution is validated, new components are ordered and tested in real production. The decision for implementation is made at the change approval meeting where the business case is presented. When the solution approaches implementation, the manufacturing engineers become more involved. The actual implementation is coordinated by the multifunctional implementation team. Issues that are very complex or the product quality department lacks the resources to investigate can be transferred to the design department.

Design: In the design departments there are some engineers devoted to running changes. The same 14 step work flow was being implemented at the time of the study, so the interviewees had not yet incorporated it into their work. Before the 14 step work flow was introduced, the two departments had developed their working methods independent of the other. The work with running changes is very similar to the work at product quality engineering, but the engineers at design usually have fewer and more time-consuming issues. The majority of the issues come from production quality engineering via product quality engineering. At times they are contacted by someone from the production directly, especially if the problem owners in production do not get response from the quality engineering departments. According to the group manager, it was however becoming more and more unusual since they want to follow the standard procedure for issues.

Manufacturing Engineering and the implementation team: These functions prepare the factory for the changed components by looking over equipment, updating assembly instructions, performing trial runs and many other activities that are not covered in this study.

Supporting systems

There are a number of different databases that are used in the process for running changes. The practical problem solving method is not incorporated in any of those, but performed on a paper form. The forms are archived in folders at the production-unit that started the process. There is however an electronic register for the forms where it is possible to track down at which production-unit the form is archived. The lessons learned function, although not used very much, results in that paper-copies of the form are sent to the chosen departments. The component analysis department archive in folders as well and use electronic registers for

tracking. Alarm issues and other requested controls are filed according to issue numbers. Paper-copies of results are distributed back to the problem owner, for instance a production-unit performing practical problem solving. The component analysis department use several databases for supplier information and supplier quality tracking. The contribution to the process for running changes is however paper-bound regarding quality engineering.

The production quality engineering department use a local issue database in the daily work, where they document the issues with text and pictures, as well as follow up with status and appointed champions. The containment authorisation is made in a Lotus Notes application. The practical problem forms are returned to the responsible production unit, but some information from them may be entered in the issue database. If the issue is escalated to product quality engineering a new project is initiated in the global problem resolution database for quality engineering. Some of the information from the issue database is transferred manually to the global problem resolution database in the root-cause description. The product quality department or design engineering department continue the investigation in the global problem resolution database, where they complete the solution section. They use another important database for administration and specification when modifying components and updating drawings. The global problem resolution database continues with a section for the implementation team and finally supports lessons learned. The lessons learned function needs to be requested and approved of by a global problem resolution database tracker at the time of issue closure. This possibility is not used by all departments. The lessons learned content is stored as a part of the problem resolution and is accessed by opening the specific issue in the global problem resolution database.

Implications of the issue handling process

The issue handling process map in figure 7 reveals a complex flow with many departments involved and several different routes that the issues can travel through the organisation. What became clear during the interviews is that the understanding of the process was usually limited to the steps immediate before and after. This has a lot to do with big organisational changes starting a few years back and still ongoing. Routines and processes that worked well before had to be replaced in favour of global standardising. The different departments are struggling to make all the new work processes function in an ever changing organisation, where new processes and databases are introduced at a great pace.

Another consequence is that locally developed systems live side by side with the global ones, since there is a reluctance to shut down the systems that have been used successfully over a long time. The support for knowledge transfer is low in this complex and changing environment. The practical problem solving method was not known to many of the interviewees that would benefit from studying the information in the forms. A small portion of the knowledge from the practical

problem solving method is usually transferred the production quality engineers. If the issue is handed over to product quality engineering or design engineering, very little of the accumulated knowledge on the issue is transferred. As one of the employees at production quality engineering put it:

“At hand over you receive 1-2 pieces of paper which is a bit thin, you want more information. Handover is never enough, you need to make phone calls, e-mail, go and visit, etc. You don’t know what tests have been made? What work has been done? You try to get hold of as much of the documentation as possible.”

During the case-study several handovers took place, and the information that was usually forwarded was a few lines of text in the global problem resolution database and the one-page description of the containment. There was no reference to the production unit where the problem was discovered and the issues felt somewhat discarded at this level. This was even more evident at the design engineering department which is physically disconnected from the production since the technical development centre is located about 500 metres away. Figure 8 below shows a graphical illustration on the knowledge transfer situation today and the desired situation. The rectangular shapes represent different pieces of knowledge that are accumulated during problem solving, and the arrows show how much of the knowledge is transferred. The figure shows how an increased knowledge transfer would decrease the workload in the quality engineering departments since there would be no need for doing the same work twice or even three times over.

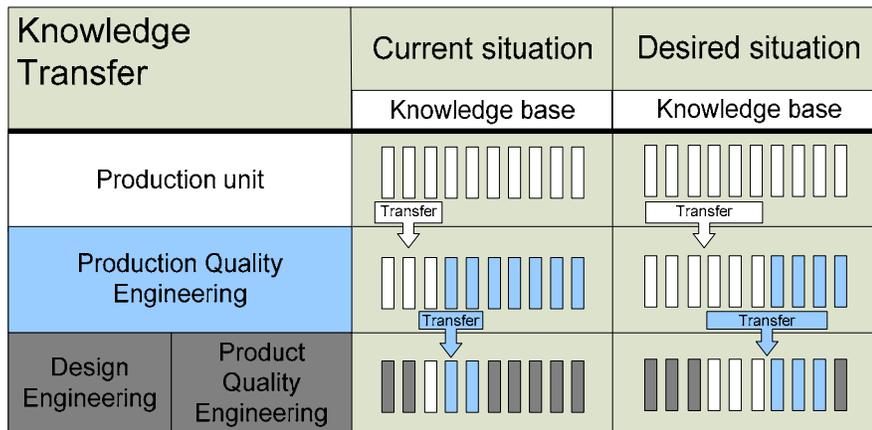


Figure 8. The knowledge transfer situation, current and desired.

Another probable consequence is that increased transparency would enhance the trust in the work of others as well as the respect. During the study it occurred that employees expressed distrust of other departments, which may have been due to the lack of understanding of the process and the roles of the different departments. Employees from several departments mentioned that their role or

responsibilities was not clear to employees from all departments they had contact with. One concrete example of that is the relation between some of the production areas and component analysis. When performing the practical problem solving, the team leader from a production line area often sends in components to component analysis. If the component fulfils the requirements in the specification the team leader gets a response that the component is correct and no action will be taken. The team leader is then supposed to hand over the issue to production quality engineering, but this is not known to the team leader who gets frustrated when they read that no action will be taken. Sometimes the same component is sent to component analysis several times and every time the response will be identical, and the frustration grows.

A second example is the relation between production quality engineering and product quality engineering, where production quality engineers can have the notion that they do the majority of the work since their containments very often turn into a permanent solution. On the other hand, a product quality engineer might argue that production quality engineers do not always test the containments properly and sometimes make sloppy investigations why they feel a need to do a second root-cause analysis to be on the safe side. These are two good examples of misunderstandings created by the fact that the process is not well defined to all involved. The two departments in the last example would for instance probably collaborate much more effectively if they were clearer about the responsibilities of the other. The production quality engineers would need to understand how much work is involved in the quality assurance process all permanent solutions undertake. It is also more likely that they come in contact with the changes that they are familiar with from developing containments, rather than being exposed to the work that involve changes in tools or complex product changes. They should also understand that the product quality engineers could resolve issues faster if they provide them with the whole background of the problem and details from the testing. The product quality engineers should have an understanding of how many issues the production quality engineers actually deal with at the same time so they cannot possibly be as thorough, but more insight in their work should also help reducing distrust.

Another problems associated with hand over is that the receiving department may not always be too keen to add more to their already quite heavy workload. One production quality engineer explained that “you cannot always appoint champions in the receiving department at the dedicated meeting. You need to find an appropriate champion yourself and persuade him or her to take over the issue.” Restrictive access permission to the global problem resolution database results in many phone calls and meeting attendances for the quality engineers only to answer question on issue status. This frequently occurs a long time after the issue has been handed over to other departments and is conceived as a pure waste of time by the quality engineers.

The central observation during the case study is that very little information is passed on at handovers where breakpoints in the process are created that hinder traceability. The discontinuous process is contributing to the poor feedback and lack of transparency in the issue handling process and makes the original customer peripheral or disconnected. There is little knowledge in the organisation on how the whole issue handling process actually works, and the complexity is increased by the continuous introduction of new work procedures and routines in different departments.

Suggestions and further research

There is a high level of complexity in the organisation which in different ways hinders effective process feedback. The issue handling process was rather obscure to many employees and the changing environment creates an even bigger need for information. The alternative process based on personal contacts is a symptom of the standardised process being inadequate or lack of feedback forcing production employees into trying to take short cuts and engaging people without system support. A first step towards a clear and unambiguous process could be that managers from all departments involved discussed the process map in this work and compared with their own ideas and the few process charts over parts of the process that exist. Together they could develop an issue handling process that would encompass all important steps and departments. This information should then be disseminated to all employees involved in running changes and quality engineering. The process should be well described on the intranet, where all employees concerned would be able to find detailed and updated information. The managers should also discuss handover and what expectations they have on the deliverables. When the managers have reached consensus on these issues, the discussion should continue at staff meetings, to make sure that all members of staff are aware of what they are expected to deliver as well as receive.

The important finding in the study that a lot of work was lost at each handover indicates further research on the subject would benefit the project. There are however a few improvements that would be worthwhile investigating at this point. The communication between departments would probably increase a lot if focus was shifted from sub optimisation and discrete department specific processes to a collaborative approach. An idea that would be interesting to try out is to gather former and future problem owners at handover to discuss the problem from many angles and go through what work has been done and by who. The handover in question is the one from production quality engineering to product quality engineering or design engineering. It would be most effective to put in an extra effort here since this is the point in the process where the connection to production becomes weak and the largest portion of knowledge is lost. A problem today is that the team leaders in production lose track of the issue at this level.

When issues are being handled by the production quality engineers, the team leaders and line area production managers can see results in form of containments and they also meet with the engineers and help them testing out new containments in their production area. When engineers look at product changes, this does not occur as often, and the team leaders are often unaware that work towards solving their problem is ongoing. This lack of feedback creates tension between departments, especially in production where feelings of being overlooked and marginalised can arise. All of this is unnecessary and easily avoided with handover meetings and enhanced feedback. One suggestion is that read access to the global problem resolution database should be granted to line area production managers and other original customers for tracking of issues and their current status.

Another improvement of the handover would be better management of the knowledge base. Information is first generated in production through practical problem solving. This information must be captured and follow the issue through the process. The production quality engineers need to understand the importance of documenting their work and saving documents such as test reports. A part of further research could be investigating the need for such meetings and what activities and participants. With current knowledge, a walk through the practical problem solving and the following root-cause and containment work would probably provide a satisfactory background to the issue, and the meeting could continue with a discussion devoted to permanent solutions. Another possible research question is finding out if this method would lead to continued interaction between the persons attending the meeting, once they are acquainted with each other.

One more suggestion for improvement of handovers is either to enhance system support for the issue handling process by only using one database for all issues or to introduce physical binders for the issues where important documents are filed throughout the process. The binders could be a first step until a common database could be realised. A bold suggestion is to shut down the local issue database used by production quality engineers and handle all quality issues in the global problem resolution database. The global problem resolution database could work as an electronic archive for open issues, where the practical problem solving forms, containment authorisation files, test results, meeting notes, FMEA:s, etc. could be stored as long as they were needed. Issues that are not yet or will not be escalated to production quality engineering could be stored in a preliminary stage in the global problem resolution database. Shutting down the issue database would also help improving the quality of data in the root-cause section. Since the issue database is used during the actual investigation, the impression was that the information in the global problem resolution database consisted of a few lines of text copied from the issue database immediate to handover. The motivation or time did not seem to be there for making proper entries of information. Instead

the same small portion information from the issue database recurred in many of the compulsory fields in the global problem resolution database.

Finally, the handover process would gain from a clear and communicated process, where the employees understood their own role in the process, and its relation to other functions.

Another field of interest for the further research is the practical problem solving method, where some difficulties were observed during the study. One important finding is that there is currently no distinction in the form between product related problems and process related problems. The process related problems are usually resolved by the problem owners in production together with maintenance. This is generally the cheapest and most efficient way, however many of the problems are actually caused by unsatisfactory design. The problems are solved in the production, which is probably the best solution, but since the issues never surface to the quality engineers, chances are slim that the original designer will ever find out there was a problem. Nor will the responsible for design best practices and there is no reason why the same problem would not recur on the next car model. It is important to find ways to ensure that the information from the practical problem solving method becomes a part of the final accumulated knowledge base for each issue. One obstacle is that the quality in use of the method varies a lot in the production. Some team leaders or line area production managers does not have motivation or skill to perform good problem solving. It is important to investigate what education is needed and how to find the right incentives to create motivation. There might also be a need for a quality assurance tool, for instance a check list, where a number of requirements must be fulfilled before the practical problem solving form can be approved. When the quality is high and consistent in problem solving, more issues would probably be solved within the production teams. The issues that would be escalated to the production quality engineers would then be fewer as well as provided with an extensive background to the problem that probably would reduce the handling time.

To conclude, this case study provided a necessary understanding of current processes in the company. The research project aims to enhance the feedback of production experience to design engineering and manufacturing engineering. In order to accomplish this, a complementary study will be made in order to understand what kind of experience is requested by different functions and also to investigate how and how much interaction takes place. This study will primarily be quantitative, why it would be a great complement to this highly qualitative study. The examples of further research in previous paragraphs are all worth pursuing once the current situation is understood.

Acknowledgments

This work could not have been realised without the help and engagement of many employees in the company. I would like to thank them for sharing their knowledge and ideas for improvements, as well as helping me finding my way through the organisation.

References

- Almgren, H. (1999). *Pilot production and Manufacturing Start-up in the Automotive Industry – Principles for improved performance*, PhD Thesis, Chalmers University of Technology, Gothenburg
- Liker, J. K. (2004). *The Toyota Way*. McGraw-Hill, Fort Worth, Madison, WI.
- Paulin, D. (2006). “The effects on Knowledge Creation and Transfer in Production Process Verification due to Virtual Prototypes” *The Electronic Journal of Knowledge Management*, vol. 4, no. 2, 181-188
- Pearce, C. L. (2004). “The future of leadership: Combining vertical and shared leadership to transform knowledge work”, *Academy of Management Executive*, vol. 18, no. 1, 47-57
- Ulrich, K. T., Eppinger S. D. (2000). *Product Design and Development (2nd ed.)*, McGraw-Hill, Fort Worth, Madison, WI.
- Wheelwright, S. C., Clark K. B. (1992). *Revolutionizing Product Development - Quantum Leaps in Speed, Efficiency, and Quality*, The Free Press Inc., New York, NY.
- Womack, J. P., Jones D. T., Roos, D. (1990). *The machine that changed the world (Extended ed. 2007)*, The Free Press Inc., New York, NY.
- Yin, R. K. (2003). *Case Study Research - Design and Methods (3rd ed.)*, Sage Publications, Inc., Thousand Oaks, CA.

Towards and understanding of the adoption mechanisms of ethnography in New Product Development

Markus Lahtinen

The Institute of Economic Research, School of Economics and Management,
Lund University, Sweden

markus.lahtinen@ics.lu.se

Abstract. Based on a synthesis of literature in New Product Development (NPD) and the field of Human-Computer Interaction, the purposes of the article are to articulate and argue for increased research focusing on the industry reception of untraditional methods on how to study users in their natural environment. The background is two-fold; one being the need for more research that focuses on the mechanisms success factors for introducing HCI-methods based on ethnography on a larger scale into formalized NPD and the other being relevance-oriented studying the shift of technology in the security sector; moving away from a 'rigid technology', e.g. mechanical locks and analog systems to 'flexible technology', based on computing power and networking, e.g. electro-mechanical locks, digital cameras and analytical software. Departing from personal interests, past academic work using a literature survey and inputs from the industry regarding strategic current issues the ambition is to employ methods aiming on 'rich' descriptions of users acting in their natural environment and more explicitly study the way these descriptions are received among NPD team members representing companies relying mostly on engineering work practices.

Keywords. ethnography, NPD, HCI, adoption, security industry

Introduction

The following statement paraphrases the introduction I had with the research project I am currently involved with:

The security industry is becoming more and more IP-based and we need to study this.

The reason for starting this article with this sentence is not to say that it is particularly well-framed sentence of the research area, rather the opposite, it is to provide the reader with an idea of how loose the initial framing was. This was the summer of 2006. By the time for the writing of this article some seven months have passed and I am better informed about the industry as such and also have had some time to reflect on how this 'IP-based' shift connects to the IS field and also some thoughts on the IS field as such. These pieces will merge and form the basis for this article.

This article is not based on any systematic empirical observations for the purpose of this article, but some of the initial observations and field-work that has been done are relevant for this article. Of course, it could be called into question if these observations could be entitled empirical due to the lack of research intention. Nevertheless, these observations impregnate the text and also act as support to some of the statements and arguments made throughout the text.

One of the most supported observations is the high-tech shift that is taking place in the industry and there are two main evidences for this shift: one being the move of a number of prominent IT-companies, e.g. Cisco and IBM etc., into the security industry. Another strong trend is the increase in demand for digital networked video, where digital cameras in CCTV-systems are the most blatant proof of this. However, the change is also visible 'behind the cables' with examples of digital video storage, software analytics etc. The shift is not purely hardware-driven but also information and software-driven in the sense that the digital streams of data lends them easier to be used in real-time software analysis. This analysis would be much more cumbersome in the case of analog parts of the system. In short, the shift is both technology and market-driven.

Turning the attention to the IS field, I will also use this article to argue in favour of the scholarly commentators that argue for the IS crisis position, i.e. the misdirected research that treats IT in a nominal manner or as a mere 'black-box'. In the section dealing with the IS field this argument will be presented as seen from the perspective of several scholars. I believe this is an important standpoint to communicate since it will guide the empirical research that will be conducted in the future.

The IS crisis will function as a background to the suggested research, and also as motivational force to the importance of studying the suggested questions. In relation to the discussion of relevance versus rigour the questions set forth in the article are based on workshops held with senior managers at three commercial firms in the security sector in Sweden and all the questions have been approved by as relevant in the feedback-round that followed the collection of the questions. The intellectual effort of this paper lies in the ‘transformation’ of the questions from being questions of high relevance to questions of more general and rigour-oriented character, paving way for the study of product and service development in the security industry.

Eriksson et al. (2000) suggests an approach to frame research questions when speaking on how they confronted the Knowledge Management domain. Rather than saying that you *define* an area at least it’s of importance to establish some outer markers for the domain you are investigating, secondly; establish a link with the domain to IS and thirdly, and in the end, to relate it to business and organizations. The structure of this paper adheres to this structure of working. The article will be organised as follows: the first section will dwell on the IS field and its so called crisis but also set a foundation for the study of the security industry. Next section will describe the security sector and its more recent and major events. The final section will synthesize these two streams into the merger of product development and the HCI-field leading to a more articulated research question.

Information systems: the IS crisis

According to Nilsson (2005) the discipline of Informatics can be seen as a studying the relationship between organisation, individuals and IT simultaneously.

The mission is to investigate how people or users develop IT solutions to support and improve work tasks in their social life. (p. 1)

This view is an important input to the discussion to what research should be about in the IS field and relates to the discussion referred to as the crisis in the IS field. Although being broad in the sense that it includes all social activities it stresses that the IS field (Informatics) comprises IT as a significant feature.

Orlikowski & Iacono (2001) discusses different views on technology based on a journal survey comprising ten years (1990-99) of ‘Information Systems Research’. They come to a somewhat puzzling result concluding that almost one

fourth of the articles on technology never dealt with IT more than on a nominal level. Other conceptualisations of IT are *tool*, *proxy*, *ensemble* and the *computational* view. The ensemble view is held as more of a realistic conceptualisation of IT than the other view that somewhat trivialises IT as being a thing or a *tool*, understood through surrogate measures (*proxy*) or merely as an advanced abacus, i.e. the *computational* view. The ensemble view recognizes the contextual qualities, e.g. social, political and historical etc. layers of the context that IT is used in. Eventually Orlikowski & Iacono (2001) suggest that more research ought to strive in the direction of the *ensemble* view while at the same time pointing out some of the problems with this view as well.

With a somewhat different approach Benbasat and Zmud (2003) points to the same problem that Orlikowski and Iacono (2001) addresses; likewise they consider that a significant part of the IS research fails to include the properties of IT and goes a little bit further concluding that occasionally the included dependant variables are not at all IS-related but rather and mistakenly taken from other fields, for example marketing or behaviour science fields. One major argument related to the diversity that arises from this type of research; who should take the responsibility in consolidating the research? Obviously this is of utmost important for the IS field in the ambition of creating a more homogenous body of knowledge.

In a commentary Agarwal & Lucas (2005) suggest that Benbasat & Zmud (2003) are suggesting a model for future research that is erroneous. The argument is quite detailed but basically it is a question of how terms such as impacts and IT-artefact are defined. Without any clear definitions it will be difficult to create a coherent field much like Benbasat & Zmud (2003) are aiming at. The conflict seems a bit pseudo in the sense that both agree on the proposition that the IS-field is in crisis and Agarwal and Lucas (2005) makes a comment that is too detailed for the type of macro question being addressed. However, their line of argument is reasonable given that they are in favour of preserving the plurality in the field. I don't believe Benbasat & Zmud would argue against this, although they have opened up for criticism by suggesting a consolidated model. Orlikowski & Iacono (2001) have a bit more 'soft' argument suggesting that no model would capture the field, but it is essentially about how IT is treated, or rather a reaction towards not treating IT at all.

El Sawy (2003) takes a more historical perspective in his article suggesting that that the distinctiveness of IT has changed through the history of computing having clear supportive tool-function initially called the connection view. This era more or less ended in the 1990's and was succeeded gradually by the immersion view that could be described as more and more integration of IT in our everyday

life and especially in business, i.e. it becomes more and more difficult to make meaningful acts without computing power. As an example, the connection between suppliers and customers through EDI-systems and bank transactions are being made almost exclusively through IT-supported IS nowadays. The 'final' integration and the loss of distinctiveness is called the fusion view where it becomes difficult to discern the IT from the business whatsoever. Some initial proof of this perspective could be seen through the use of Enterprise Systems that connects many of the basic functions of a company into one integrated system, i.e. the business becomes tightly coupled with the IT/IS-systems. If this view holds true in the future – and there is evidence for this – surely this calls into question the different view presented by Orlikowski and Iacono (2001) making a strong argument for the ensemble view in relation to the fusion perspective.

The article by Alter (2006) stresses the use of an alternative perspective – the work system-perspective – which positions Alter more clearly into El Sawy's (2003) holistic perspective of fusion. In short, Alter suggests that a work system is the perspective to have avoiding the infected dichotomy of the IT-artefact and organisation (use).

The field seems to be in a situation that is more of a cross-road, while in everyday academic life 'business is as usual' not paying attention to the cross-roads that the field is actually standing at. Then I also guess that a word like crisis feels a bit too strong, opening up for a bit of credit to the ones that defend the current position of the field of not being in a crisis. However, it does seem problematic that a significant part of the research displays little or no understanding of the 'material' we actually are working with. Eventually this will have to be dealt with, but I do not think this subject is on the verge of collapsing. Quite the opposite, the IS-field is sought for more than ever and there will surely be a steady demand in the future. This is much attributed to the ever increasing need and demands for IT in today's society. However, for the research project I am involved in studying the security industry it will be imperative to dig deeper into what is meant by IT with the background of the technology shift that is taking place there currently.

The follow-up question is how this re-attention to IT should be achieved? It would be unfair to dismiss much of the research having been made in the past as being poor science. Many of the studies relates to the consequences and effects of IT in business settings focusing solely on the effects and consequences *per se* and not tying the bits and pieces together, i.e. discussing what the effects and consequences tell us about IT as such. The obvious answer is to describe the technology in technical terms but that would miss the point of the argument because it would equate it to any other description of technology, missing out on

the unique features of networked computing based technology. On the other hand maybe computing technology only can be understood through its consequences as a base for describing it?

Summarizing this section:

The IS field includes the study of IT in use by individuals and organisations (companies and society level)

A significant part of past research have trivialised, 'black-boxed' or even neglected IT, taking a circumstantial view of IT

There is a movement of IT becoming less distinct and ubiquitous in our everyday life (incl. business)

And, IS field needs to readdress the IT in IS research opening up for new perspectives and approaches to understand how to develop effective and useful IT-support for human activity in an efficient and satisfactory manner.

Industry: the security industry

The security industry and its customers are currently experiencing a major technological shift with regards to the products and services being offered; a move that heads towards offerings that increasingly are based on a computer-based networked infrastructure catering an increased demand from customers to lower the costs of security, i.e. replacing human man-guarding with technology. Some commentators have called this a type of 'convergence' that is taking place in the industry.

This gives a somewhat erroneous view to what is actually happening; since what we are observing is mainly a change of technological *infrastructure*, while the idea of 'convergence' would hold true in some cases where electronics is combined with mechanical parts, e.g. an electro-mechanical lock. Nevertheless, a major shift is taking place and will keep on going with larger portions of products containing digital computing power and electronics. To give the reader a 'taste' on what is mostly demanded, ASIS (unknown), which is the largest association for security professionals in the world, have made survey of what' is on US-based companies purchasing 'wish-list': CCTV surveillance, access control and video cameras. There are emerging technologies that are not included here, e.g. biometrics and RFID-technology, which has not yet reached any breakthrough with regards to purchasing among customers to a larger extent.

The shift was quite neatly framed by a security manager representing a 'high-street' bank with some 30 of experience of the security sector suggesting a shift in staffing and knowledge requirements from 'alarm engineers' to 'IT engineers',

while at the same time suggesting the shift is gradual and not as rapid as the industry suggest it is. The 'alarm engineer' could be described as one having experience in handling electronic circuiting and the construction of closed systems (typically alarm-systems), while the 'IT engineer' has a competence in the construction of open and networked based systems running on computing power. Open in this case refers to the possibility of upgrading the systems fairly easily with the introduction of new software or connecting auxiliary equipment to an existing network.

Regarding the size of the industry (economic value) it varies significantly depending on the source and could be explained from the difficulties of setting the boundary conditions on how to define the industry. Another way of estimating size is to count the number of actors in the industry and in the different parts of the value system in order to estimate degree of fragmentation and possibilities of economies of scale. The security industry is highly fragmented with thousands of national actors (SMEs) seen from the larger markets, i.e. USA, United Kingdom, Germany, France and Spain. For example there are numerous local installers in the US competing partially with the larger systems integrators.

On the customer side this technology shift also manifests itself in changing functions and competencies required with the function, e.g. security managers are more likely to be recruited for being knowledgeable in IT rather than having a pure security background from law enforcement, military or the secret service.

The assumption in my research track is that this will create several challenges for the whole industry as well as its customers. One of the challenges relates to the knowledge required in the future in order to survive on the market place; where the IT companies obviously has an advantage in their understanding of computers and networking while the traditional security companies are still perceived as the ones that understand and deliver 'security' which acts as their current competitive advantage.

New Product Development

Thompson & Strickland (1992) discuss product innovation in relation to industry and competitive analysis as key strategic process within any firm. It holds the potential of expanding into new customers segments as well as revitalising the offering compared to what immediate competitors are doing. One of the driving forces of any industry (ibid.) is technological change and the spread of IP in security measures is arguably a change that will have large impact on the industry landscape.

Staying innovative requires firms to make the process of innovation explicit and product development is one of the areas that deal with a systematic approach on how to deal with innovation. The more formal name is New Product Development (NPD) and from now on this term use used instead.

Just as the case of any key business process – be it operational or strategic – most often it is represented as a series of steps that leads to a set goal of the process. The process of innovation is no exception to that norm; Ulrich and Eppinger (2004) present a generic description of a product development process:

- (0) Planning
- (1) Concept Development
- (2) System-Level Design
- (3) Detail Design
- (4) Testing and Refinement
- (5) Production Ramp-Up

Without going into depth on each of these steps, a liberal interpretation of these steps would suggest a movement from fuzziness (step 0) down to more concrete shape and styling of the product being developed (steps 4 and 5). The initial steps that are often referred to as the ‘fuzzy front-end’ of NPD very much because of the complexity in understanding customers changing preferences and also the competing internal forces of different stakeholders internally, e.g. production, marketing etc.

This study will attempt to integrate methods from the field of Human-Computer Interaction into the ‘fuzzy-front end’ of NPD. Past research attempts (e.g. Cagan and Vogel, 2002, Kumar and Whitney, 2003, Masten and Plowman, 2003), where more untraditional methods (e.g. prototyping, video ethnography etc.) of studying user behaviour, have been done before and the results have shown that there is a potential in using these methods.

Less research has focused on the impact of these methods have on firms holding a more traditional mindset, largely based on engineering approaches to NPD. Although research suggests that these innovative methods have the potential in enriching the NPD process I believe a force holding back on these methods is the attitude among NPD team members of viewing these methods largely different from how NPD has been done in the past. This blind-spot is worth investigating to a greater extent focusing on the perceptions of the team members being exposed to these untraditional methods.

HCI and Ethnography

HCI deals mainly with the design of interactive systems to create effective, efficient and satisfactory interaction for a given user or a group of users affected by the system being designed (ISO, 1998). Another important condition is that effectiveness, efficiency and satisfaction are to be understood contextually:

The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

In the case of interaction the contextual quality displays itself for example in the case of providing feedback on interaction that can be related to the efficiency-side of the interaction at hand. Studying the interaction with web pages in a laboratory setting (Lahtinen, 2001) one of the test users was to add an item into familiar shopping basket on an on-line shopping site. Expecting that the page was reload when the item was added, instead the page did not reload but added the item to a client-side temporary memory-displayed shopping basket furthest down on the page making the user clicking on the item several times and hence adding several instances of the item instead of the single item that was requested in the test protocol.

The above example shows that feedback actually was provided, but not in the way it was expected to be provided meaning that interaction on a shopping site on the Internet has its own contextual qualities that general rules of thumb does not cover.

Moving away from the laboratory setting, ethnography has established itself as commonly used method in the HCI-field. The roots of ethnography can be traced back to disciplines like anthropology and sociology. It functions as a technique for understanding use contexts and humans acting in their natural environment which makes it quite different than from experimental methods based on a laboratory setting.

In accordance with Siegel and Dray (2005) I will refer to ethnography as a rather broad concept in this article being a generic term for untraditional methods in understanding users while usability refers to a traditional set of method and techniques mostly based on studies in laboratories.

Several studies within HCI have confirmed the potential and advantages of using methods, e.g. ethnography and its derivations, to study interaction in natural use settings. However, a commonly reported disadvantage is the time consumption it entails of using ethnography. In my own experience a one-hour

video recorded interaction containing video streams of the user and the output device (monitor) has an analysis ratio 1:9 meaning that one hour of recording takes 9 hours to analyse. This has opened up for research focusing on light-weight techniques at times referred to as 'rapid ethnography' (e.g. Cunningham and Jones, 2005, Millen, 2000).

Although the promising results of employing ethnography in understanding users and having the potential of being used in formal product development, there is still a far way to go in getting a more general acceptance across several industries. I believe this especially holds true in the case of industries historically being manufacturing firms based on solid engineering skills, which are slowly moving into the direction of being more attuned to becoming more service and consultancy oriented.

In order for ethnography to get stronger foothold I believe it will become critical to understand the detailed mechanisms regarding the reception of ethnography.

Integration of NPD and HCI: description of the case companies

Companies A and B are both positioned as manufacturers up-streams in the value system (cf. Porter, 1985) of the industry. The company C holds a position in direct contact with the end-users of the value-system, which positions C quite differently than A and B. However, C uses products manufactured by A and B which links them together. A is a one of the global players in the security industry and has grown dominantly mechanically during the past decade, now hosting numerous brands and businesses. B has its origins in the IT-industry but acts simultaneously in the security industry manufacturing high-technological security products. C is a systems integrator and service-provider meaning that they analyse and design security solutions offering installations as well as maintenance to their customers.

The position of A and B is interesting from a product development perspective in the sense that these companies don't have direct and immediate contact with the end-customers. This poses a challenge for these companies to intercept changing preferences among its end-customers and also potential clues on how their products are to be developed. Having their value system-position in mind, the shift of technology base will change preferences and knowledge of both the customers as well as the industry, meaning that capturing of feedback from end-customers will be key in order for A and B in order to offer competitive products

on the market place in the future. This is confirmed from the field-study conducted during the autumn of 2006 by both companies in their willingness to know from whom the end-customers expect to receive support from in the future: the systems integrator or the manufacturers? Being a service provider and direct contact with the end-customers - Company C has an interest in understanding the changing preferences of their current customers and much like companies A and B has solid knowledge in engineering work practises.

With the introduction of 'flexible' and advanced technology the patterns of how product development is conducted is changing consequently. In all cases there will be need to understand their customers better than their competitors. Using more untraditional methods of studying users the research will seek to describe and understand the perceptions and impacts on NPD team members having an engineering background of using these untraditional methods to study users in the fuzzy front-end of NPD.

The methods and techniques from the HCI-field have been researched and developed to create effective, efficient and satisfactory interaction with computing-devices. The security sector is experiencing a shift to be based on networked computing devices, suggesting that the HCI-methods are applicable which would be argument for considering this research being positioned in the field of Information Systems and Informatics.

References

- Agarwal, R. & Lucas, H.C. (2005). "The information systems identity crisis: focusing on high-visibility and high-impact research", *MIS Quarterly*, 29(3), 381-398
- Alter, S. (2006). "Works systems and IT artifacts – Does the definition matter?", *Communications of AIS*, 17, 299-313
- ASIS (unknown). "The ASIS Foundation Security Report: Scope and Emerging Trends – Executive Summary", Alexandria, Virginia, USA
- Benbasat, I. and Zmud, R.W. (2003). "The identity crisis within the ID discipline: defining and communicating the discipline's core properties", *MIS Quarterly*, 27(2), 183-194
- Cagan, J. and Vogel, C.M. (2002). *Creating Breakthrough Products: Innovation from Product Planning to Program Approval*. Upper Saddle River, NJ: Prentice Hall PTR.
- Cunningham, S.J. and Jones, M. (2005). "Autoethnography: a tool for practice and education" *ACM International Conference Proceeding Series*; Vol. 94, Proceedings of the 6th ACM SIGCHI New Zealand chapter's international conference on Computer-human interaction: making CHI natural, pages 1-8
- El Sawy, O.A. (2003). "The IS core –IX: The 3 faces of IS identity: connection, immersion, and fusion", *Communications of AIS*, 12, 588-598
- Eriksson, I.V., Dickson, G.W. & El Sawy, O.A. (2000). "Reflections on designing field research for emerging IS topics: the case of knowledge management.", *Communications of the AIS*, Vol. 3, Article 6.

- ISO (1998): Guidance on Usability, ISO 9241-11
- Kumar, V. and Whitney, P. (2003). "Faster, Deeper User Research", *Design Management Journal* 14(2):50–55 (Spring).
- Lahtinen, M. (2001). "Usefulness, utility and usability applied on three on-line shops on the Internet", *Master thesis, Department of Informatics, Lund University, Sweden* (In Swedish)
- Masten, D.L. and Plowman, T.M.P. (2003). "Digital Ethnography: The Next Wave in Understanding the Consumer Experience", *Design Management Journal* 14(2):75–81 (Spring).
- Millen, D.R. (2000). "Rapid Ethnography: Time Deepening Strategies for HCI Field Research", *Symposium on Designing Interactive Systems, Proceedings of the conference on Designing interactive systems: processes, practices, methods, and technique, New York City, New York, United States, Pages: 280 - 286*
- Nilsson, A.G. (2005). "Information Systems Development – Some Highlights from Infology", *Department of Information Systems, Karlstad University, Sweden*
- Orlikowski, W.J. and Iacono, C.S. (2001). "Research commentary: desperately seeking the "IT" in IT research—a call to theorizing about the IT artifact", *Information Systems Research*, 12(2), 121-134.
- Porter, M. (1985): *Competitive advantage : creating and sustaining superior performance*. New York : Free Press, USA
- Siegel, D., Dray, S. (2005). "Avoiding the next schism: ethnography and usability", ACM Press, *Interactions*, Volume 12 , Issue 2 (March + April 2005), Pages: 58 - 61
- Thompson, A.A. & Strickland, A.J. (1992). *Strategy Formulation and Implementation*. Fifth edition, Richard D. Irwin, Inc., Boston, MA, USA
- Ulrich, K.T. & Eppinger, S.D. (2004): *Product design and development*. Third Edition, New York, McGraw-Hill, USA

Boundary Actors in User-Developer Communication

Minna Koskinen
University of Jyväskylä, Finland
miko@jyu.fi

Anne Pirinen
University of Jyväskylä, Finland
apirine@jyu.fi

Abstract. Boundary actors are individuals located and acting in the intersection of different groups intended to enhance and support communication and learning across group boundaries. We review 13 articles addressing boundary acting in user-developer communication in IS journals and identify different tasks of, and requirements for boundary acting in cross-boundary communication. The findings are reflected upon a layered model of communication. The model identifies different layers of meta-knowledge that human beings use for interpreting messages: social knowledge, working knowledge, content knowledge, symbolic knowledge, and computational knowledge. Communication is not possible without this meta-knowledge. Our findings suggest that social knowledge is needed for understanding and learning to take place in boundary acting. By constituting the wider context of the communication situation, social knowledge seems essential for correct interpretations to occur also on the other layers of communication. It is necessary for people who communicate to acknowledge and adopt each other's meta-knowledge to be able to achieve mutual understanding in a communication situation.

Keywords. Systems development, boundary actors, communication, learning.

Introduction

Communication between users and system developers is one of the most important issues in systems development (e.g. Bostrom, 1989; Fisher, 1999; Hartwick & Barki, 2001; Keil & Carmel, 1995; Kraut & Streeter, 1995). This is the phase where user knowledge and developer knowledge should interact effectively in order for the project to design and implement a system that meets user needs (Salaway, 1987). Knowledge is distributed among various persons and

it needs to be processed and combined successfully (Butterfield, Coopriider & Rathnam, 1994). Bostrom (1989) suggests that end-users and developers have different frameworks through which they perceive the surrounding world. The capability to integrate these different views into a common model of the system is foremost important for a successful development project. Through communication, mutual trust and influence between users and developers may be increased (Nelson & Coopriider, 1996). Successful communication results in shared meanings and mutual understanding among the participants.

Communication does not take place without lurking problems and hence, we need to understand what makes communication successful or unsuccessful in creating correct understandings. Knowledge transfer as part of communication involves knowledge transmission and knowledge absorption (Eskelinen, Kokkinen, Koskinen & Tyrväinen, 2004). Even when knowledge transmission i.e. information exchange occurs successfully, knowledge absorption i.e. learning may fail. As users and developers have different expectations on each others' critical skills, roles and understanding (Wynekoop & Walz, 1999), a key question is whether the parties become to understand each others' strengths, weaknesses, and frameworks.

To transfer knowledge efficiently, users and developers must understand each others' needs and how they can contribute to the tasks at hand. Because users and developers come from divergent organisational groups, it is relevant to study boundary actors and boundary acting as mediators of communication and learning. Boundary actors are individuals who are located at the intersection of different groups, while boundary acting is intended to enhance communication across group boundaries. In this study, we are specifically interested in the issues that are important for communication and learning to take place in such cross-boundary work.

We begin by discussing related research on user-developer communication and learning, as well as research on boundary acting and boundary objects in user-developer communication. Then we describe the layered model of communication that we use as the theoretical framework to understand boundary acting as support for cross-boundary communication. Next we review 13 articles in scientific IS journals addressing boundary acting and user-developer communication. By users we mean people who use the developed system in their daily work, while developers are people responsible for the design and implementation of the system, e.g. designers, analysts, and programmers. Users may also play the role of a developer, but these cases are omitted since we are specifically interested in boundary acting. Thereafter, we discuss the findings in contrast to the layered model of communication. Finally, we draw some conclusions.

Research on Boundary Acting and Communication

User involvement or participation in information systems development (ISD) and its role in system success has been an important research topic in information systems research during the last decades. Several researchers (e.g. Sonnenwald, 1995; Fisher 1999; Hartwick & Barki, 2001; Gallivan & Keil, 2003) have studied user participation and especially user-developer communication as a part of participative action. According to Curtis, Krasner and Iscoe (1988), development of large software systems must be treated, at least in part, as a learning, communication, and negotiation process. Also Gallivan and Keil (2003) and Zhong and Majchrzak (2004) argue the importance of communication and learning, because diverse stakeholders have different knowledge, concepts, assumptions, relationships, approaches, interests, and goals. Many researchers (e.g. Curtis et al., 1988; Heiskanen & Similä, 1992; Mathiassen & Pedersen, 2005) have emphasised the need for developers to create, share and refine knowledge about application domains, technologies, and project conditions.

Communication is often a troublesome task. Several studies (e.g. Long et al., 1983; Tan, 1994; Gallivan & Keil, 2003) have identified problems and their effects on user-developer communication, user participation, and ultimately on project outcomes. Factors influencing communication breakdowns include different cognitive and communicative abilities of individuals, different representational formats, different work contexts, local jargon and cultural norms. Many of the causes of communication breakdowns stem from the fact that communication between users and developers takes place between two divergent groups (Pan & Yap, 1999). Several studies have also suggested solutions to these problems. Janson, Woo and Smith (1993) state that the discourse must include models understandable for both parties. The use of technical communicators (Fisher, 1999), interpreters or translators (Curtis et al., 1988; Janson, Woo & Smith, 1993; Sonnenwald, 1995) can also assist in achieving a mutual understanding between users and developers. Some researchers (e.g. Kraut & Streeter, 1995; Pan & Yap, 1999) have discovered that the choices of communication style (formal vs. informal), communication channels and the frequency of communication are suitable for different types of activities at different stages of the development process. Keil and Carmel (1995) also remind that direct and indirect forms of communication are suitable for different situations and goals.

Learning as a part of communication has also attracted interest. Even though effective communication activities are an essential part of successful ISD (e.g. Salaway, 1987; Curtis et al., 1988) they do not alone lead to learning (Zhong & Majchrzak, 2004). Newman and Noble (1990) emphasise the importance of two-way communication because it works as a precursor of learning. Vandenbosch and Higgins (1996) propose there are two forms of learning: model maintenance

and model building. When efficient and effective mutual insight is required for ISD outcomes, model building is considered to be a more important form of learning (Kirsch & Beath, 1996; Zhong & Majchrzak, 2004). Eskelinen et al. (2004) perceive absorption of knowledge, as part of knowledge transfer, to be inherently a learning process involving both explicit and tacit knowledge. In a similar vein, Walz et al. (1993) consider knowledge acquisition, sharing and integration as central activities for learning necessary knowledge. Although there are also other factors that bear on the outcomes, an effective learning process is critical to the success of ISD (Lyytinen, 1987; Wastell, 1999; Lyytinen & Robey, 1999; Zhong & Majchrzak, 2004).

Atwood et al. (1995) point out a need for building infrastructures that support relationships, work practices, and social intercourse among communities of learners and knowledge workers. Levina and Vaast (2005) continue by emphasising the need for competencies for spanning the boundaries of professional fields and organisations and especially the specific role of boundary spanners, or “boundary actors” in more general terms. Boundary actors play a vital role by facilitating the sharing of expertise between two or more groups of people separated by location, hierarchy, or function. Boundary actors may operate in varying roles e.g. in informational or representational boundary roles (Aldrich & Herker, 1977; Tushman & Scanlan, 1981). Several researchers (e.g. Long et al., 1983; Curtis et al., 1988) acknowledge that boundary actors may assist in avoiding or reducing communication breakdowns. However, also weaknesses and failures in boundary acting have been reported. For example, Heiskanen and Similä (1992) point out problems such as thin spread of application domain knowledge, conflicting requirements and communication breakdowns. This means that the skills and qualities of a boundary actor have a significant influence on the success of boundary acting.

Besides boundary acting, communication across group boundaries can be aided also by the use of boundary objects. Star and Griesemer (1989) define boundary objects as “objects which are plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites”. Thus, boundary objects assist in communication and knowledge transfer across the boundaries by offering some common ground between divergent groups. According to Carlile (2002) an effective boundary object establishes a shared syntax or language for individuals to represent their knowledge, provides a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary, and facilitates a process where individuals can jointly transform their knowledge.

Layered Model of Communication

Koskinen, Liimatainen, Berki and Jäkälä (2005) introduce a layered model of communication in the context of information systems and human interaction. They emphasise that human communication is not simple information transfer from a sender to a receiver through some information channel, and that words cannot fully transfer knowledge, not even information. They posit that to articulate and understand information, a human being needs to perform a complex, many-layered interpretation task using his or her meta-knowledge related to the message, the other party, and the situation. This meta-knowledge functions tacitly so that people can focus on the delivered messages and comes into focus only when reflecting upon it (e.g., while studying means of communication and ways of performing).

Communication between two persons emerges from two-way mental-physical transformations that proceed through five layers. At each layer, a specific type of meta-knowledge contributes to the creation or interpretation of the message. Most of this meta-knowledge is not directly communicated but is yet required for to understand the meaning and purpose of the message.

- *Social knowledge* relates to human and social intentions and their implications on human and social worlds, and the fundamental human assumptions and belief and value systems. It may also concern discourses and communication, and personal and social emotions.
- *Working knowledge* deals with the environment and present conditions, and their effect in this context. It also includes knowledge that helps to create new knowledge to use and process information in a given situation, and historical knowledge of the conditions and factors present in a given situation.
- *Content knowledge* deals with the purpose of information entities, the intended meaning of concepts and conceptual relationships used in an information entity, and the conceptual structure of an information entity.
- *Symbolic knowledge* deals with the way of representing information entities. It includes, for example, knowledge of how certain symbols should be interpreted and how different information entities are represented.
- *Computational knowledge* concerns the way how information entities are technically and physically implemented and processed. It includes, for example, knowledge of how information entities are implemented and processed as signals and signal flows, and knowledge of the concrete technical implementation and processing of information entities as physical objects.

Although Koskinen et al. (2005) point out that all social interaction occurs through the physical world, they restrict their interest specifically in the mental-physical transformations that occur in the mind of persons who interact with each

other. For our purposes, we need to extend this model to account for phenomena on the physical layer, and adopt the term “knowledge object”.

- *Knowledge objects* are physical codifications of combined knowledge and knowledge processes that are produced and used as mediators of communication. A unique characteristic of the human mind is awareness of knowledge objects and the capability of giving a multitude of meanings to these objects.

In our view, communication and learning are inseparable. Learning requires communication, and also vice versa, communication requires learning. To be able to achieve mutual understanding in a communication situation, it is necessary to acknowledge and adopt the other person’s meta-knowledge in order to interpret the actual meaning of the message and to make an authentic transformation from transferred data into information and further into knowledge. Therefore we can conclude that successful communication and knowledge transfer cannot occur without learning of the other person’s meta-knowledge. This also sets a limitation for the role of boundary objects. Boundary objects are knowledge objects that mediate knowledge transfer across boundaries on the physical layer. We see that even though boundary objects can aid communication and knowledge transfer, they cannot facilitate knowledge transfer as efficiently as boundary actors, because boundary objects cannot create situation-specific and context-sensitive translations between different meta-knowledge bases on the upper layers of communication.

Boundary Actors in Systems Development – a review

We review 13 scientific journal articles, each of which reports an empirical study on communication and boundary acting in systems development. The purpose of the review is to increase our understanding of the role of boundary actors and boundary acting as facilitators of communication and knowledge transfer in systems development. We are especially interested in where and how boundary acting may facilitate communication and knowledge transfer on the upper layers of the communication model and how meta-knowledge is related to it. For this review, we searched digital libraries for journal articles that deal with communication and systems development. From these articles we chose the ones that explicitly concern some form of boundary acting as a means for improving communication in systems development. Here we also looked for referenced articles to include them in the review. In the following, we report the major statements we identified in the selected studies concerning these issues.

Curtis, Krasner and Iscoe (1988) find that substantial time commitment is required at learning the application domain in depth. Developers have to learn and integrate many forms of information and knowledge about diverse areas, and occasionally even about how different users perform the tasks. Some individuals

may have remarkable control over project direction and outcome due to their superior application domain knowledge. They may perform broader roles and be recognized as the intellectual core of the project by other project members. These individuals are extremely familiar with the application domain and able to map between different knowledge domains. They are adept at identifying unstated requirements, constraints, and exceptional conditions, and their broad understanding allows them to integrate different, sometimes even competing perspectives. These individuals usually possess exceptional communication skills and often spend much of their time educating others about the application domain and its mapping into computational structures. They become focal points of communication, providing others more knowledge about the system. They are also a primary source of coordination in a project and are willing to engage in networks that assist a project's technical integration. They are often crucial in keeping communication channels open between rival groups.

Bostrom (1989) finds that parties involved in systems development bring different frames of reference to communication. The parties have different domain knowledge and use vocabulary of their domain. Achieving mutual understanding through effective communication helps to promote shared meaning and creating a common frame. Reframing changes the way a person frames and understands events and thus changes the meaning of the events. Thereby, the person's responses and behaviors also change. The greater the semantic gap between parties, the more effort in communication is required to establish semantic equivalence. If vague language is used and more specific information is not requested, the questioner must fill in gaps based on his or her own frame. The listeners then draw the assumptions they believe are most appropriate. This creates an opportunity for misunderstanding. Although shared frames have not been created, the parties go on operating under the assumption that their own view is shared by the other. Verbal statements and questions allow the communicator to both guide the direction and to ensure that the discussion stays within the established outcome frame. These questions may prompt for evidence, challenge relevancy, or be cues or probes to elicit specific information.

Heiskanen and Similä (1992) study gatekeepers that are organizational actors located at the junction of several communication channels and able to regulate the flow of communication between organizational parties. In case different actors have different views of the desired features of the future system, the gatekeeper must act as a compromiser between the disagreeing parties, while in case an actor changes his or her view, the gatekeeper must step aside as early as possible to enhance the mutual learning of the users and the developers at the earliest point. The gatekeeper has the power to control the interaction of other actors through formal and also quite often informal decision making (managerial role). The gatekeeper is also able to act as an intermediate, mainly between the users and the developers (substantial role). Combining both managerial and substantial

gatekeeper roles into a single person reduces the amount of communication needed and enhances the decision making, but also requires considerable experience and skills that may be lacking in many circumstances. The gatekeeper may use his or her organizational position either to increase his or her own power or to thwart the aggrandizements of others.

Janson, Woo and Smith (1992) find that because language is an instrument for effecting change, it must be analyzed and interpreted in terms of the speaker and the hearer's social environment as communicative action. Instrumental action is evaluated using technical criteria, which implies assessing the efficiency by which success is achieved. Instrumental action is appropriate in non-social setting. Strategic action seeks to influence decisions of a rational opponent and its success requires that the hearer accepts the speaker's actions as suitable with respect to interpersonal authority and power relations. Communicative action has goals based on mutual acceptance, and therefore reaching understanding takes priority over rational efficiency, calling for candor, truthfulness, sincerity, and veracity as the validity claim. Progressing from instrumental action through strategic action to communicative action implies validity claims of increasing complexity. Meaningful user involvement and participation with individuals acting as equals occurs only when there is veracity. Design uncertainty and user resistance can play an important role ensuring system success. The designers' sensitivity to non-technical issues, accompanied by an appropriate communicative strategy, encourages meaningful user participation, results in an understanding and alleviation of user resistance, and enhances the prospects for successful system implementation.

Williams and Begg (1993) find that users cannot be expected to describe their work and needs in the language and the point of view of the developer, while developers seldom have an intuitive grasp of their users' working life or the environment in which a product will be used. For the dialogue between a user and a developer to be meaningful, the discourse must include models that both parties can understand. A third party can serve as translator between the users and the developers. By enabling the user to participate in design, the translator may also be able to overcome the user's reluctance to confide in the developer and trust him or her to turn privileged information into a useful tool. The translator is accepted and trusted by both users and developers as somebody who speaks their language and knows how their work responsibilities are being affected by the project, i.e., as someone who meets their criteria of competence. Translation concerns not only interpretation of tasks and terminology but may include also negotiation and facilitation and it may occur either within the design group or between the design group and other interest groups. The translator role is arduous and can be performed well only by a few people with exceptional context-dependent qualities, and thus deserves recognition and reward but should not be institutionalized since it could foster rigidity in the translation process.

Tan (1994) finds that ineffective communication stems from differences, e.g., in personality, perceptions, attitudes and values, roles and functions, and cognitive processing. Mutual understanding can be fostered through shifting perspective, managing transaction, and establishing rapport. It is established when individuals working toward a mutual objective are able to comprehend what the other party is trying to do and why that party does what he or she does. Shared meaning implies that communicators must have similar cognitive choices and that they know they share the same knowledge domain. When communicators select similar cognitive objects, they share common codes or rules and there is less misinterpretation and misinformation and less cognitive dissonance between the communicators. Cognitive dissonance can make information processing stressful and problematic when confronted with multiple alternatives.

Kraut and Streeter (1995) find that barriers between groups (geographical, organizational, or social) reduce people's opportunities and eagerness to share information and to learn from distant colleagues. Although compartments promote organization efficiency in large groups by shielding people from unnecessary information, they also limit people's breadth of experience leading to errors, narrowness, and insufficient opportunity for comparing knowledge. They may also reduce the motivation to interact with relevant others and to accept new ideas. Formal tools and procedures address the problems of coordination only partially. Formal communication, which is carried out through relatively non-interactive and impersonal communication channels, is useful for coordinating routine transactions within groups and organizations. Informal communication, which is personal, peer-oriented, and interactive, is instead useful in the face of uncertainty. It is the primary way that information flows into and through R&D organizations. Also, the ease of acquiring information (e.g. physical proximity) is at least as important as the quality of the information in determining the sources that people use. However, the inefficiencies of pair-wise face-to-face communication may preclude its use as a practical technique in large sized projects.

Sonnenwald (1995) identifies several roles that span group boundaries and assist inter-group communication. Agents foster goodwill among participants by providing opportunities for communication among participants, reinforcing the super-ordinate goal, and helping participants negotiate differences. Conflicts among groups during development seem to arise from deviations from prior decisions, theme incompatibilities, language differences, incomplete specialized knowledge, and power relationships. Boundary translators explain their group's perspective for participants in other groups to increase their knowledge and understanding about the group. External stars interact with people outside the design situation to get ideas and to validate or receive recognition for their expertise. Gatekeepers filter information that originates outside the group to the group members, and also withhold information from group members if seen

necessary. Inter-group starts interact frequently with members from other groups and represent their group during those interactions.

Nelson and Coopriider (1996) find that shared knowledge must be expressed in words or symbols that are common to the social domain of the parties involved. There must be sensitivity to and appreciation and understanding of the frames of reference and interpretations of other parties. When faced with information that is not consistent with their own reality, humans experience internal conflict (“cognitive dissonance”). The way how the customer articulates design and support needs may be foreign and inconsistent with the terminology and methods the developers use and understand. Thus the developers may attempt to translate the message without sufficient domain knowledge to interpret the requirements. By understanding what motivates group members to seek knowledge and reduce inconsistency, it is possible to identify the mechanisms that facilitate knowledge transfer between groups. Antecedents of shared knowledge are mutual trust based on mutual commitment and a stable long-term relationship, as well as mutual appreciation and ability to influence each other in the process.

Gallivan and Keil (2003) find that ineffective communication can negate any benefits that might accrue from high levels of user participation. Project managers must question what information users may not readily volunteer, and try to create an environment where users feel free to share their concerns. Effective communication cannot occur when users withhold negative feedback about a system, either because they perceive such views to be “undiscussable” or because prior history has shown that such negative feedback will be ignored. The way how user participation is managed has much to do with the negative outcomes that occur. Even if there were numerous communication channels established for user-developer feedback, they ultimately might be proved ineffective. A combination of weak signals from the users, a substantial “noise” citing various incidental problems diverting attention from the actual ones, and selective perception on the part of the developers can lead a project to failure.

Jin and Montague (2003) find that there may be unintended consequences of rational control measures and deviations from the original plans and initial concerns that reflect as problems in communication in a development project. There are several potential sources of communication problems. There may be underlying conflicting interests and self-defense needs in a troubled project situation, power imbalance between user and developer groups, and a concomitant lack of mutual trust. It may be assumed or believed that the initial “rational” project organization structure and guidelines for project control, once in place, would reasonably guarantee project success. The participants may lack understanding of the unrealistic project deadline and unmanageable project scope, be unprepared for unforeseen or unexpected events in changing environment and deviations from the original plans, and be unable to make flexible and timely feedback adjustments. Based on the case description, we are also able to identify

a serious lack of proper communication skills and knowledge as a source of serious problems.

Zhong and Majchrzak (2004) find that stakeholders must not only learn others' knowledge but must adapt their own knowledge to the specific context through learning. The authors identify two types of adaptation. In model maintenance, learning occurs when new information fits into the existing mental models and confirms what is already held to be true. Model building, instead, can be described as the "creation of a new domain view" and involves the synthesis and restructuring of each party's perspective on goals, interests, beliefs, assumptions, business, and technical knowledge. Essential in facilitating learning are the self-elaborations that explanations generate. Elaborated explanations help individuals to explore and develop their understanding and acceptance. The socio-cognitive conflict involved encourages individuals to explain and justify their positions and to seek new information to solve disagreements. This cognitive clarification leads to spontaneously constructing an understanding of the problem. In fact, the elaborator learns more efficiently and effectively in the learning process than the listeners.

Levina and Vaast (2005) find that continuity of local practices allows people to act knowledgeably in a given material, historical, and social context. At the same time, however, they are also distinguished from others who do not practice in similar fashion. Discontinuities in practice (i.e., boundaries of fields) create opportunities for organizations to develop a knowledge-based competitive advantage. Engaging members from different fields in their relating practices ("boundary spanning") develop a knowledge-based competence in product development. Integrating various sources of expertise requires overcoming obstacles associated with knowledge embeddedness and tacitness. Success requires that organizational members are effectively engaged in practices that allow them to span the boundaries of diverse settings. Boundary spanners facilitate the sharing of expertise by linking two or more groups of people separated by location, hierarchy, or function. Multiple roles of boundary spanners may often come into conflict, thereby leading to stress and burnout since they are expected to be both sensitive to social cues and competent in multiple domains. The ongoing use of an artifact by agents within a specific social context is what gives it meaning and makes it an actual boundary object. To use an artifact means to incorporate it symbolically into the ongoing dialogue about the practice.

Our findings are summarized in Table 1. The table enumerates the main tasks and skills of boundary actors that are presented in the articles and associates them to the layers of the layered communication model. Boundary actors appear to be a useful means to improve cross-boundary communication— especially on the layers of social and working knowledge – to close the semantic gap between users and developers in systems development.

Tasks and skills	Layers	References
Understanding different perspectives and interpretations	Social knowledge	Curtis et al. 1988; Nelson & Coopriider 1996
Creating mappings between knowledge domains	Social knowledge	Curtis et al. 1988; Levina & Vaast 2005
Understanding conflicting interests and needs, and possible power imbalance and lack of trust	Social & working knowledge	Jin & Montague 2003
Facilitating cooperation and emergence of trust	Social & working knowledge	Curtis et al. 1988; Janson, Woo & Smith 1993
Creating links and mediating between parties	Working knowledge	Heiskanen & Similä 1992; Levina & Vaast 2005
Providing opportunities for communication	Working knowledge	Sonnenwald 1995
Guiding the flow of communication	Working knowledge	Bostrom 1989; Sonnenwald 1995
Regulating the flow of communication	Working knowledge	Heiskanen & Similä 1992; Sonnenwald 1995
Negotiating differences and compromising	Working knowledge	Heiskanen & Similä 1992; Sonnenwald 1995
Translating between parties	Several layers of knowledge	Williams & Begg 1993; Sonnenwald 1995
Creating common models and language	Several layers of knowledge	Williams & Begg 1993; Nelson & Coopriider 1996; Zhong & Majchrzak 2004
Reconciling between domains and vocabularies	Several layers of knowledge	Curtis et al. 1988; Bostrom 1989; Tan 1994; Sonnenwald 1995
Good communication skills and sensitivity to social cues, domains and context	Several layers of knowledge	Curtis et al. 1988; Levina & Vaast 2005; Janson, Woo & Smith 1992; Williams & Begg 1993

Table 1. Main tasks and skills of boundary actors as surfaced in the review

Discussion

Boundary actors are vital individuals who facilitate the sharing of expertise by linking two or more diverse groups and providing a possibility to control communication channels between them. The main tasks of boundary actors appear on the upper two layers of the communication model. On the social layer, a boundary actor acts as an intermediate between the parties and creating links between them, translates between the parties, and facilitates the discourse by aiding in creating models and language that both parties can understand and compromising when there are disagreements. On the working layer, a boundary actor provides opportunities for communication among participants, reinforcing the super-ordinate goal, and helping participants negotiate differences, regulates the flow of communication between parties, filters and withholds information if necessary, and facilitates in-depth communication by guiding the direction of discussion and prompting for further information and clarification.

Our findings suggest that social knowledge is a key factor for understanding and learning to take place in boundary acting. By constituting the wider context of the communication situation, social knowledge seems essential for correct interpretations to occur also on the other layers of communication. This becomes clear in cross-boundary communication. Boundary actors should be familiar with the knowledge domains involved and able to create valid mapping between them, and to be able to reconcile different frames of reference, different domain knowledge, and different domain vocabularies. Competence in multiple domains and understanding of different perspectives is required with adeptness at identifying unstated requirements, constraints, and exceptional conditions. Also good communication skills and sensitivity to social cues and to the context is needed, as well as sensitivity to and appreciation and understanding of the frames of reference and interpretations of the different parties. The underlying conflicting interests and self-defense needs should be understood, as well as the possible power imbalance between parties and a concomitant lack of mutual trust. Boundary acting is clearly a challenging task that poses various demands for skilful boundary actors.

Our view that it is necessary for people who communicate to acknowledge and adopt each other's meta-knowledge to be able to achieve mutual understanding in a communication situation is supported by the analyzed studies. Language must be interpreted in terms of the other party's social environment. Boundaries between groups are formed in a given material, historical, and social context as local practices evolve into a unique fashion and they limit people's breadth of experience leading to errors and narrowness. Learning each other's knowledge and adapting one's own knowledge to the specific context is necessary, which also requires overcoming obstacles caused by knowledge embeddedness and tacitness. The greater the knowledge gap between parties, the more effort is

required in communication. Without sufficient information, the listener has to fill knowledge gaps by his or her own meta-knowledge, which may lead the parties to operate under a false assumption that they share their view. With common meta-knowledge shared by the parties, there is better understanding and less misinterpretation between the communicators. Through boundary acting, communication and the achievement of mutual understanding is possible, because boundary actors can provide information about the social contexts of different parties, i.e. essential meta-knowledge needed in the interpretation and knowledge absorption process.

Boundary acting requires social sounding and mutual learning, in which a new domain view is created through the synthesis and restructuring of each party's perspective on goals, interests, beliefs, assumptions, business, and technical knowledge. Boundary actors can facilitate the achievement of mutual understanding and learning of the parties by interpreting information into an understandable form for other groups or individuals, serving as a customer or user representatives, facilitating cooperation and emergence of trust or functioning as a connection node between customers and developers. It is necessary that the boundary actor is accepted and trusted by all parties as somebody who speaks their language and meets their criteria of domain competence. Boundary actors also can foster mutual understanding through shifting perspective, managing transaction, and establishing rapport. Explaining one's own view generates self-elaborations that are essential for learning because they help individuals to explore and develop their understanding of the problem. Moreover, by understanding what motivates group members to seek knowledge and reduce inconsistency, it is possible to identify mechanisms that facilitate knowledge transfer between groups.

In our view boundary objects are tightly connected to the communication and social context. Boundary objects offer a physical connection between different parties and therefore provide a common ground for communication and knowledge transfer. In our extension of the layered communication model, boundary objects i.e. knowledge objects are located at the physical layer which functions as a channel for social interaction. Boundary objects store situation-specific and context-sensitive information because they receive their meaning from the ongoing use of an artifact by agents within a specific social context and the use of a boundary object incorporates it symbolically into the ongoing dialogue about the local practice. Boundary objects may function as a mediator in the cross-boundary communication situation but they alone cannot provide necessary knowledge needed for the right transformation from data to knowledge. For the transformation process to be successful, boundary acting becomes a necessity.

Conclusion

We conducted an analysis of 13 articles in scientific IS journals in order to identify different aspects of boundary acting as facilitators of communication in information systems development. The core statements were reflected upon the layered model of communication presented by Koskinen and others (2005) that we extended with the notion of knowledge objects at the physical layer. The findings are insightful and help to identify different requirements of boundary acting.

We can conclude that communication can be facilitated by boundary actors and boundary objects. Actions taken by another party should not be interpreted merely through one's own meta-knowledge and mental frame but learning the other party's meta-knowledge is required. Power relationships should be organized in such a way that problems are minimized or do not arise at all. To our view, a skilful boundary actor should be able to identify and familiarize oneself with the contexts in a communication situation, to assess the degree of heterogeneity in a communication situation, and to facilitate participants to escape strong frames when necessary for problem solving and to create a new common frame. It is important to detect fundamental challenges in the communication situation and to identify and adopt suitable communication techniques to overcome them. A boundary actor should be able to provide an infrastructural frame for communication by clear and responsible decisions, principles and instructions, to read between lines but look also for disconfirming evidence for assumptions and conclusions. A boundary actor should also be able to make a sensitive issue voiced but not forcing it open to excess criticisms that would suppress it, and, to show the participants care and understanding of their position, although not necessarily acting upon it for good reasons.

We find the layered model of communication feasible for framing different aspects of communication and learning in user-developer interaction. The findings suggest that social knowledge is a key factor for understanding and learning to take place in boundary acting. By constituting the wider context of the communication situation, social knowledge seems essential for correct interpretations to occur also on the other layers of communication. The findings also support our view that it is necessary to acknowledge and adopt each other's meta-knowledge to be able to achieve mutual understanding in a communication situation. We also perceive a strong connection between boundary objects, social context and communication. In the future, we need to conduct more detailed and more focused studies to enlighten the different aspects of boundary acting, communication and learning in relation to the layered model of communication. Also more research on the role of boundary objects as knowledge objects should be carried out.

References

- Aldrich, H., and D. Herker (1977). "Boundary Spanning Roles and Organization Structure", *The Academy of Management Journal*, vol. 2, no. 2, 217-230.
- Atwood, M.E., Burns, B., Gairing, D., Girgensohn, A., Lee, A., Turner, T., Alteras-Webb, S., and Zimmermann, B. (1995). "Facilitating Communication in Software Development", in G. M. Olson and S. Schuon (eds.) *Proceedings of the Symposium on Designing Interactive Systems: Processes, Practices, Methods and Techniques, DIS '95*, pp. 65-73, ACM Press, New York, NY.
- Bostrom, R. (1989). "Successful application of communication techniques to improve the systems development process", *Information & Management*, vol. 16, no. 5, 279-295.
- Butterfield, J., Coopriker, J.G., and Rathnam, S. (1994). "Resolving Cognitive Conflict in Requirements Definition: a Blackboard-based Model and System Architecture", in J.W. Ross (ed.) *Proceedings of the 1994 Computer Personnel Research Conference on Reinventing IS: Managing Information Technology in Changing Organizations*, pp. 105-115, ACM Press, New York, NY.
- Carlile, P. (2002). "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development", *Organization Science*, vol. 13, no. 4, 442-455.
- Curtis, B., Krasner, H., and Iscoe, N. (1988). "A Field Study of the Software Design Process for Large Systems", *Communications of the ACM*, vol. 31, no. 11, 1268-1287.
- Eskelinen, J., Kokkinen, A., Koskinen, M., and Tyrväinen, P. (2004). "Comparing the Applicability of Two Learning Theories for Knowledge Transfer in Information System Implementation Training", in Kinshuk, C.-K. Looi, E. Sutinen, D. Sampson, I. Aedo, L. Uden and E. Kähkönen (eds.) *Proceedings of the IEEE International Conference on Advanced Learning Technologies*, pp. 206-210, IEEE Press, Los Alamitos, CA.
- Fisher, J. (1999). "The value of the technical communicator's role in the development of information systems", *IEEE Transactions on Professional Communications*, vol. 42, no. 3, 145-54.
- Gallivan, M.J., and Keil, M. (2003). "The user-developer communication process: a critical case study", *Information Systems Journal*, vol. 13, no. 1, 37-68.
- Hartwick, J., and Barki, H. (2001). "Communication as a dimension of user participation", *IEEE Transactions on Professional Communication*, vol. 44, no. 1, 21-36.
- Heiskanen, A., and Similä, J. (1992). "Gatekeepers in the action structure of software contracting: A case study of the evolution of user-developer relationships", *ACM SIGCPR Computer Personnel*, vol. 14, no. 1-2, 30-44.
- Janson, M.A., Woo, C.C., and Smith, L.D. (1993). "Information systems development and communicative action theory", *Information and Management*, vol. 25, no. 2, 59-72.
- Jin, K.G., and Montague, R. (2003). "Continuous Communication Control Disruptors during Systems Development", *Systemic Practice and Action Research*, vol. 16, no. 6, 393-420.
- Keil, M., and Carmel, E. (1995). "Customer-Developer Links in Software Development", *Communications of the ACM*, vol. 38, no. 5, 33-44.
- Kirsch, L., and Beath, M. (1996). "The enactments and consequences of token, shared, and compliant participation in information systems development", *Accounting, Management and Information Technology*, vol. 6, no. 4, 221-254.
- Koskinen, M., Liimatainen, K., Berki, E., and Jäkälä, M. (2005). "The Human Context of Information Systems", in *Proceedings of the 38th Hawaii International Conference on System Sciences, HICSS-38*, January 4 - 6, Big Island, Hawaii.

- Kraut, R.R., and Streeter, L.A. (1995). "Coordination in Software Development", *Communications of the ACM*, vol. 38, no. 3, 69-81.
- Levina, N., and Vaast, E. (2005). "The Emergence of Boundary Spanning Competence in Practice: Implications for Implementation and Use of Information Systems", *MIS Quarterly*, vol. 29, no. 2, 335-363.
- Long, J., Hammond, N., Barnard, E., Morton, J., and Clark, I. (1983). "Introducing the interactive computer at work. The users' views", *Behaviour and Information Technology*, vol. 2, no. 1, 39-106.
- Lyytinen, K. (1987). "Different perspectives on Information Systems: Problems and Solutions", *ACM Computing Surveys*, vol. 19, no. 1, 5-46.
- Lyytinen, K. and Robey, D. (1999). "Learning Failure in Information System Development", *Information Systems Journal*, vol. 9, 85-101.
- Mathiassen, L., and Pedersen, K. (2005). "The dynamics of Knowledge in Systems Development Practice", in *Proceedings of the 38th Hawaii International Conference on Systems Sciences, HICSS-38*, January 4 - 6, Big Island, Hawaii.
- Nelson, K.M., and Coopriider, J.G. (1996). "The contribution of shared knowledge to IS group performance", *MIS Quarterly*, vol. 20, no. 4, 409-432.
- Newman, M., and Noble, F. (1990). "User Involvement as an Interaction Process: A Case Study", *Information Systems Research*, vol. 1, no. 1, 89-113.
- Pan, D., and Yap, C.M. (1999). "Effective Information Processing between Users and Developers during Information System Project Development", in *Proceedings of the 32nd Hawaii International Conference on System Sciences, HICSS-37*, January 5-8, Maui, Hawaii, USA.
- Salaway, G. (1987). "An Organizational Learning Approach to Information Systems Development", *MIS Quarterly*, vol. 11, no. 2, 244-264.
- Sonnenwald, D.H. (1995). "Contested collaboration: A descriptive model of intergroup communication in information system design", *Information Processing and Management*, vol. 31, no. 6, 859-877.
- Star, S., and Griesemer, J. (1989). "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39", *Social Studies of Science*, vol. 19, 387-420.
- Tan, M. (1994). "Establishing mutual understanding in systems design: An empirical study", *Journal of Management Information Systems*, vol. 10, no. 4, 159- 182.
- Tushman, M., and Scanlan, T. (1981). "Boundary Spanning Individuals: Their Role in Information Transfer and Their Anecedents", *The Academy of Management Journal*, vol. 24, no. 2, 289-305.
- Vandenbosch, B., and Higgins, C. (1996). "Information acquisition and mental models: An investigation into the relationship between behaviour and learning", *Informations Systems Research*, vol. 7, no. 2, 19-214.
- Walz, D., Elam, J., and Curtis, B. (1993). "Inside a software design team; knowledge acquisition, sharing and integration", *Communications of the ACM*, vol. 36, no. 10, 63-77.
- Wastell, D. (1999). "Learning Dysfunctions in Information Systems Development: Overcoming the Social Defences with Transitional Objects", *MIS Quarterly*, vol. 23, no. 4, 581-600.
- Williams, M.G., and Begg, V. (1993). "Translation between Software Designers and Users", *Communications of the ACM*, vol. 36, no. 4, 102-103.
- Wynekoop, J.L., and Walz, D.B. (1999). "Characteristics of High Performing IT Personnel: A Comparison of IT Versus End-User Perceptions", in J. Prasad (ed.) *Proceedings of the 1999 ACM SIGCPR Conference on Computer Personnel Research Citation*, pp. 209-218, ACM Press, New York, NY.

Zhong, J.J., and Majchrzak, A. (2004). "An Exploration of Impact of Cognitive Elaboration on Learning in ISD Projects", *Information Technology and Management*, vol. 5, no. 1, 143-159.

IRIS (1978-2006) Historical Reflection through Visual Analysis

Judith Molka-Danielsen

Associate Professor, Molde University College, Norway

j.molka-danielsen [at] himolde.no

Matthias Trier

Dr-Ing., Technical University of Berlin, Germany

trier[at]sysedv.tu-berlin.de

Vadim Shlyk

Technical University of Berlin, Germany

Annette Bobrik

Technical University of Berlin, Germany

Markku I. Nurminen

Professor, University of Turku, Finland

Abstract. IRIS (Information Systems Research in Scandinavia) Conference is an annual meeting for researchers in Scandinavia. Through 29 annual conference meetings a social network of co-authorships and general research collaboration has emerged. This article contributes a historical reflection and analysis of the social network of researchers associated with the IRIS in the period from 1978 to 2006. We make use of the network visualization and analysis tool called Commetrix. We will examine the influence of certain researchers in this network by identifying their betweenness centrality and degree centrality. We will reflect on the nature and characteristic of the research topics by analyzing the network of keywords found in the conference paper titles, and visualizing their representation in the network.

Introduction

Information Systems Research in Scandinavia or IRIS is an annual meeting of researchers of information systems that began in 1978, where the first meeting took place in Tampere, Finland. Indeed the first 4 meetings were in Finland, championed by founders Pertti Järvinen and Pentti Kerola, and a majority of Finnish contributors. After that time the meetings have rotated among the Scandinavian countries of Denmark, Finland, Norway and Sweden. One participant that came in the early years and has attended nearly all the meetings is Markku I. Nurminen. He describes through his experience the birth of the conference and the founding elements of the research community, “The scientific community in Information Systems Research was, indeed, existing in the Scandinavian countries already before that date (of the first IRIS).”(Nurminen, 1997, p.48) But, how do we evaluate the significance of IRIS? It was founded as a forum where the ideas of Scandinavian researchers could be debated, expressed, and explored. This also prepared works for a greater impact on the international scientific community. Nurminen expresses this motive in the early meetings:

“The discussion in all four meetings was focused on systemeering and systemeering method(ologie)s, which also was the explicit intention. The specific theme of IRIS 2 was ISAC¹ and of IRIS 4 the PSC² model. Another passion was the definition of the basic concepts and their underlying assumptions.”(Nurminen, 1997, p.51)

In 2006, some of these terms will no longer be found in present day article titles. Terms like “infologically oriented systemeering” have transferred meaning to terms like “Information Systems Development” in more recent literature. (Lundeberg, et al., 1981), (Goldkuhl, 2006) While citations are often used to determine impact of research in research communities, we think this is only one measure. Social networks of themselves have great social value and lead to future collaborations. This paper will examine a social network of co-authors that presented works in association with the annual IRIS conference. We will use social network analysis (SNA) to examine the centrality of some of the IRIS community members in contributing to the growth of this community of researchers. In addition, we will reflect on the evolution of topics in this network over time using a novel technical method to visually animate the actual dynamics of the co-authorship network over time.

This paper is organized as follows: relevant research is presented in the Literature Review. The section Research Methodology informs of our source of data and approach. Visual Results through Commetrix are next presented. This

¹ “In 1973 ISAC was an acronym for Information Systems for Administrative Control. Later it was changed to Information Systems work and Analysis of Changes.” (Goldkuhl, 2006, p.1)

² PSC is a systemeering model with three phases: semantic (S), pragmatic (P) and constructive (C). It was much discussed at the early IRIS meetings. (Kerola, 1979) (Kerola and Järvinen, 1979) (Kerola and Taggart, 1980) (Taggart, 1980)

section is followed importantly by Interpretation of Results in a Historical Context and summarized in Concluding Remarks.

Literature Review

“Social networks are information networks of humans interacting and creating relationships. A link between two persons in the network can be a close friendship, partnership, or working relationship. (Molka-Danielsen, Berge Søvik, 2005) Many studies examine the general structural and dynamic network characteristics of social networks, and in particular of emerging researcher networks.” (Barabási, Jeong, et al., 2002) (De Castro, Grossman, 1999) (Grossman, 2004) (Newman, 2001)

In our study of the IRIS co-authorship network we use social network analysis (SNA) to identify key persons in the network and the spreading of keywords in the article titles over time.

Authors are the actor *nodes* of the social network. They are individuals. Co-authors on articles may be from the same or different countries.

Links or ties between the actor nodes (authors) are existence of at least two persons names (listed as authors) on one article that was presented at one of the IRIS conferences. It is not necessary for the author to have been present at the conference. The ideas are considered shared in retrospect, because the conference took place. (We would have liked to do analysis on the “working groups” at IRIS, but time and incomplete data did not permit it.)

The *relationship* between the nodes of this network can be strengthened with each new co-authored article between any two authors. The co-authorship relationship is not directional. We pursue two modes of analysis. In the accumulative analysis the strength of a tie does not depreciate with time. Alternatively, it is possible to look at time slices of the network, i.e. to examine relationships within a time window of 1 year, 5 years, any length up to the full 29 year period. This allows indicating the situation within defined period (cf. figure 4).

We use several metrics of SNA commonly used to examine the individuals in the network, these are: *direct contacts* (that is the number of first degree co-authors), the *betweenness centrality* and the *degree centrality*. These measures have been defined by Wasserman and Faust (1994) and by Freeman (1979). We adhere to these definitions and note applied differences in the appendix.

Direct contacts are a measure of the activity of an individual actor. This is the number of direct co-authorships with another person.

The *count of papers* are a count of how many papers a person contributed to, that is, was an author or a co-author. Individually authored papers are counted in the network as self-relations.

The *degree centrality* measures the importance of an actor by counting the

number of direct contacts of an actor in ratio with the standardized maximum number of direct contacts. This measure depends on what connected component of the network the actor is a part of, and the time period in consideration.

The *betweenness centrality* is a measure of interpersonal influence that an actor has on others. It refers to how many pairs of actors the actor in measure stands between. If two other actors in a network can only contact each other through a third actor, this third actor holds a social capital that can manipulate the resources on the sides. (Burt, 1997) Our measure of betweenness centrality is based on Wasserman and Faust (1994) however, because of the size of the network; it is based on only one shortest path between actors. This alternative approach is supported in (Brandes, 2001).

Degree centrality and *betweenness centrality* are expressed as egocentric measures. These along with *average degree* or *average betweenness* are also part of the general or global network properties. Another global property includes the *diameter*. These measures for IRIS (reported later in Table 4) are given for the largest connected network component. The *diameter* is the average longest shortest path between any two actors of a network. This can be an expression of the spread of the network. The *average degree* can be used to measure the likelihood of a large connected component, where most members of the network are a member of the large component. In addition to these global characteristics we examine ego-centric characteristics of key members of the network.

Research Methodology

The data on the IRIS co-authorship community has been collected through a variety of sources. These include the IRIS-History web-pages that contained data from 1978 to 1998. (Accessed in 2006: <http://www.cs.utu.fi/IRIS/hist.htm>) From 1999 to 2006 we had PDF files of proceedings on CD and sourced the IRIS Conference web site: (<http://www.cs.auc.dk/IRIS/conference/conference.html>). Finally, we sought and found “missing pieces” of information from the personal (printed) archives of Markku Nurminen.

In order to prepare the data for network visualization with the employed analytical tool Commetrix, the data was first entered into a database. Figure 1 gives a simplified account of the adopted data model. It can be represented using the tables *Author and Message*.

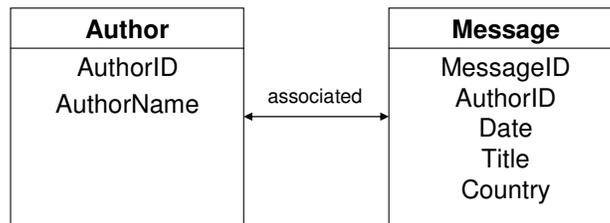


Figure 1. Simplified IRIS data model

The table “*Author*” has the field “AuthorID.” For every author an AuthorID and AuthorName were stored.

The table “*Message*” represents all submitted papers of the conference with attributes: MessageID (every paper has a unique number), AuthorID (the first author of the paper), Date (it is a unique parameter for time (year) of the conference that the paper was submitted), Title refers to the title of the paper and Country (numerically refers to the origin land of the all authors of the work in the year submitted). As Commetrix initially has the intention to visualize message based structures, papers were stored as Messages together with the parameters described.

Difficulties in creating the database can be described in two categories: problems with incorrectly written names or given names of the participants and secondly the unequivocal identification of the origin of the participant. In the first case it concerns the orthography of the Scandinavian names and given name. In contrast to English there exist other letters (å, ø, ä, ö, æ, etc.) in all Scandinavian languages (as well as in German, Spanish, etc.) that were written in some cases in the different ways. If we look, for example, at an author with the name Anders Mørch, we saw that his name appeared several times under different spellings: Anders Mørch, Anders Morch, Anders Moerch or Anders Mörch. So we sometimes had to do research after respective persons on the Internet, so that we could be sure that these were really not different persons. Also the first names with the surnames were sometimes reversed or represented differently (abbreviated) in different years. (For example: Marie Luise Christ Neumann and next time Marie L. Christ-Neumann). Data cleansing took several iterations to be sure that the same person did not appear as new persons and did not receive a new AuthorID.

The second factor of difficulty was that for a time span of 29 years that many people have done research in different places. They may be associated with different countries or universities. The location is therefore associated with the authors of the paper in the respective year.

In the second phase of our methodology the data in the database was imported into Commetrix so that visual analysis could be performed on the network. Originally, Commetrix was developed as a software application to support visual

representation of electronic communications (in the form of e-mail exchanges) of large geographically separated groups. (Trier, 2005) Later, its application has been extended and generalized towards the dynamic visualization and analysis of other sources of network data (e.g. business process networks). This made it possible to adapt the method for the purpose of our present analysis. With that, we are able for the first time to create novel insights about the dynamics and the evolution of co-authorship networks. Changes or transitions over time can now become a subject of study. With the incorporation of topic filtering we are further able to study the lifecycles of defined topics in the overall academic discourse of our dataset. Our methodology with the use of Commetrix, was as follows:

- Import of the author names, academic and location affiliations of the authors, IRIS conference article titles, conference locations, and conference years.
- Extraction of association of authors as represented through co-authorships on conference articles. This network is the visually represented knowledge community.
- Visualization and evaluation of community properties, structures and the dynamic behaviors of the network portrayed through a longitudinal representation of data over 29 years.

Visual Results through Commetrix

The key factors that we examine are:

- How has the IRIS network of co-authorship associations grown over time;
- Who are the central figures represented through betweenness and centrality statistics;
- What are central topics (themes) as represented in the titles of the IRIS articles and how do they change over time?

By relating our visual analysis to these questions we may be better able to understand the impact and benefits that the IRIS conference has brought to the information systems research community in Scandinavia and minimally, of the impact of contributing authors' individual efforts on the community as a whole.

General Network Characteristics

In Figure 2 we see the entire IRIS network of accumulated co-author associations from 1978 to 2006. The network is comprised of 1252 participants of whom Figure 2 shows the 1219 persons as nodes who are authors of papers. 80 percent of them (976 persons) participated as a co-author on a paper. This collaborative effort is represented by the links in the network of Figure 2.

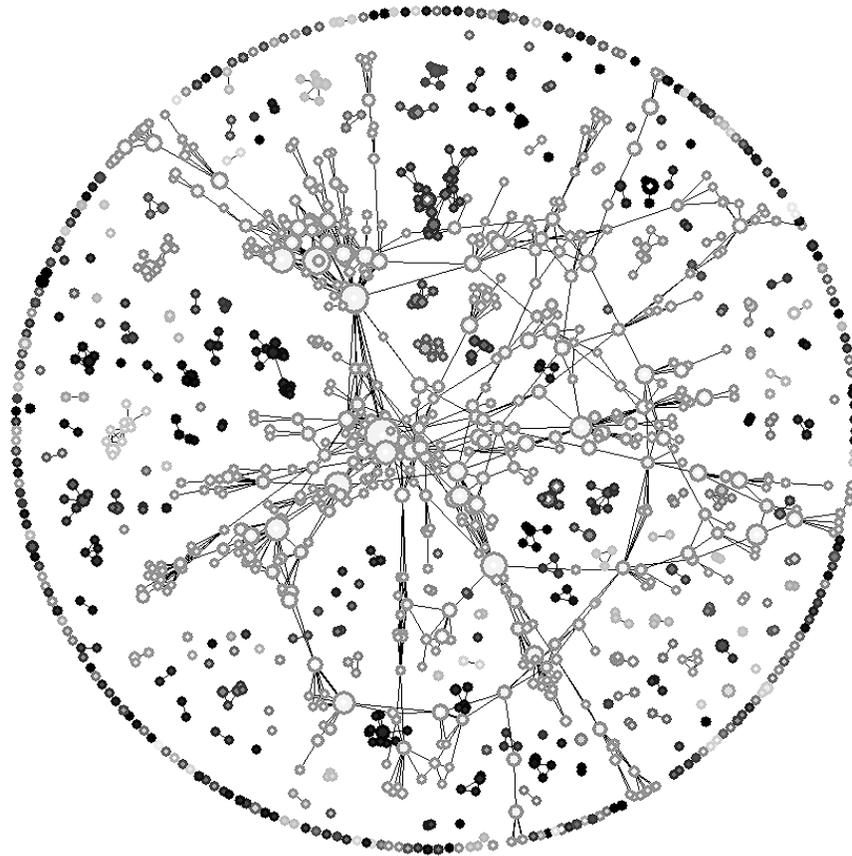


Figure 2: The complete author and co-author relationship network.

The node size in Figure 2 represents each person's activity measured by paper-counts in which the author was a participating co-author. Different node shades represent the various groups of linked authors (a larger colored version is available at <http://www.commetrix.de/iris>³). The network graph shows a co-author network comprised of one large component of 541 linked authors (44%) and several smaller clusters with the second largest cluster only containing 23 authors (2%). Over time, the 44% authors of the large component have produced a very interrelated and large researcher network. Within that cluster, there are several highly connected sections around core sets of linked participants. The graph implies that the network is dominated by those 500 actors and their collaboration. More peripheral co-authorships, which do not belong to this central cluster, appear as small network components, meaning that they remained much

³ All the graph visualizations in this article are available via this paper's online supplement at <http://www.commetrix.de/iris> and in addition further detail of all the images of this article can be seen in this pdf file by adjusting the view to 200% or larger.

more isolated and less complex. About 10 actors appear very active (large nodes) in this network. Looking at their embeddedness it can be seen, that those active authors are also the more central persons in the IRIS network. This finding is also supported in Figure 3, which shows a reduced subset of 256 actors with a minimum of three contributed papers. The larger the node size the more contacts a node has in the researcher network and the lighter the nodes' color shade the larger is the contributed number of co-authored papers.

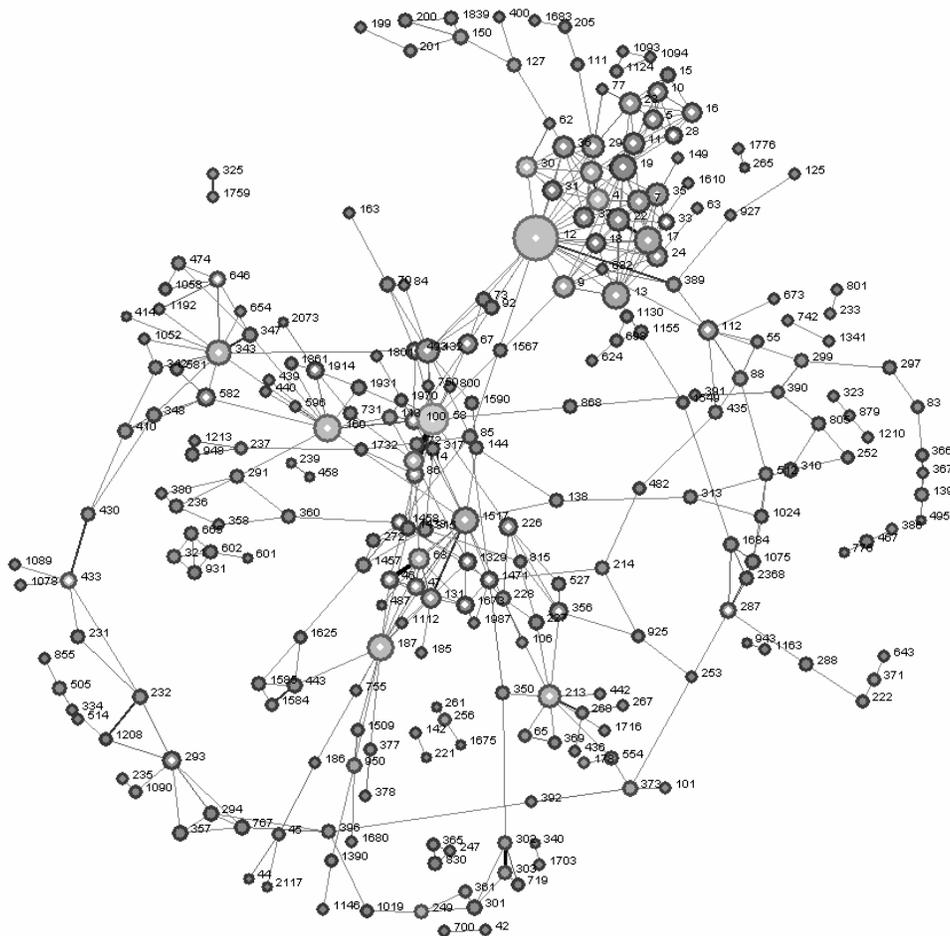


Figure 3. Subset of 256 actors with a minimum of three contributed papers (440 relationships). (density=1.35%; average degree = 4,182 links).

Generally more connected (larger) nodes are also more actively publishing at IRIS (lighter color shades). In Figure 3's core structure of the IRIS co-authorship network, a central axis emerges with nodes 12, 58, 1517, 160, and 187 at the

center. Several will be analyzed in more detail in our analysis of centrality and ego-networks later in this section. Next to this highly integrated central structure a second pattern can be found in the core network of IRIS co-authorships. It appears as long paths reaching out towards the periphery of the network and as very large (intertwined) rings with more than 13 steps. The authors positioned in these structures form large chains of peer relationships. Each participant of such a structure entertains only a very small set of two or three co-authoring peers. Those peers are embedded in the same structure and so on.

Further insights can be achieved by analyzing the evolution of the network. Figure 4 demonstrates four snapshots of the IRIS network's development across time. The visualization and a corresponding animation of the actual evolution of this network over time can be best examined using the online supplement at the referenced website.

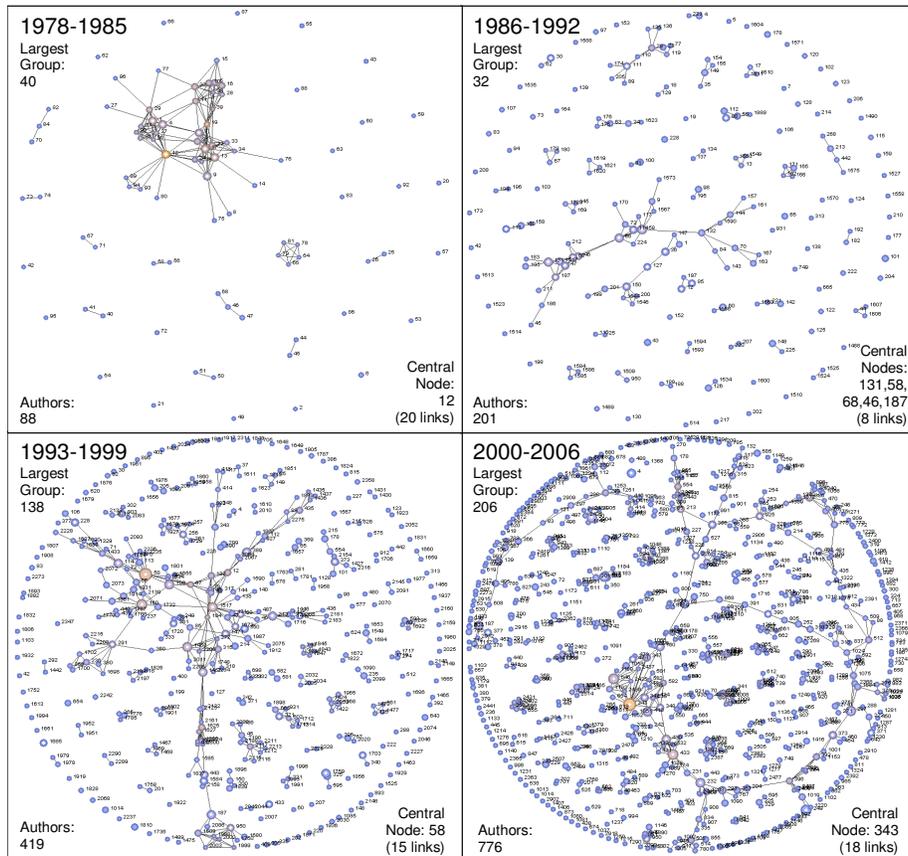


Figure 4: The different states of IRIS network in four periods (relationships outside the period are ignored).

This Figure 4 further shows the number of authors during the selected four periods, e.g. between 1978 and 1985 the co-authorship network contains 88 authors (those who alone contributed papers are included). Nodes and links before

and after the filtered period are not displayed. This gives an impression of the actual differences in the network structures. The node size is related to the contributed papers of an author, the color shade represents the direct relationships. Also, the number of the largest group and the ID of the most central node are given. During the period 1986-1992, this position was shared by 5 authors (46, 58, 68, 131, and 187). Names are not shown in the graphs, but a low number generally indicates an early first occurrence of the author in our 29 years of data, indicating that these central nodes in the second period were already participating in the first period. The figure shows, that in the first quarter of the sample period (1978-1985) many individual papers have been published, but one dominating triangular cluster with 40 members and many co-authorships was present. There is one very central author (node 12). In the next seven years this cluster loses its central position and declines to a pair of small linear subnetworks which however reaches out to new peers. Next to this change, around the small triads of the first period a different dominant cluster with 32 participants appears. It also has a linear shape with a central axis of co-authors. The overall number of actors of IRIS has risen recognizably but still many authors are isolated contributors. The volume of the conference further grows in the third period (1993-1999). The largest cluster of the second period grows 138 people. From the central nodes of period two, node 58 emerges as the best connected IRIS participant. From the initial core participants, only author 12, who was the most central node in the first observed period reconnects to the large cluster, establishes a larger number of direct ties, and becomes an integral part of the active axis of period 3. Most of the remaining structures formed by the initial core group disappear. The network structure of this component is shaped like a star with a relatively dense connected center and linear chains of actors reaching towards the periphery. Finally in period four, the center of the network moves again. The main change is the strong development on the indirect path between the dominating node of period 2 and 3 and a new node, 343, which has been in a peripheral side arm in period 3. This node emerges to become the best connected scientist in period 4 and establishes a very dense center around him. Node 58 is still integral in period 4. The previous star structure somewhat dissolves and very long paths (which sometimes close to form ring structures) appear.

Resulting from this dynamic analysis, a constant shift of the epicenter of activity can be observed. The initial cluster almost dissolves and gives way to a second core which builds for a long time and slowly transitions in its center. By separating the analysis into four shorter temporal periods it uncovers that the final network clustering is reduced to predominantly linear networking formations. As most papers are written by two or three authors, this implies that there are small working groups of two or three peers which are only sequentially connected.

Statistics of the Yearly Paper Count

A summary of the yearly paper count and number of unique authors are represented in Table 1.

Year	Host Country	Host Location	Author Count	Paper Count
1978	Finland	Tampere	15	16
1979	Finland	Dragsfjärd	10	14
1980	Finland	Saarijärvi	19	18
1981	Finland	Oulu	26	23
1982	Sweden	Stockholm	17	12
1983	Norway	Øystese	25	17
1984	Finland	Helsinki	37	26
1985	Denmark	Århus	30	23
1986	Sweden	Lund	36	29
1987	Finland	Tampere	52	42
1988	Norway	Røros	39	35
1989	Denmark	Skagen	63	37
1990	Finland	Turku	53	38
1991	Sweden	Umeå-Lövånger	45	36
1992	Norway	Larkollen	84	56
1993	Denmark	Copenhagen	113	81
1994	Finland	Syöte	97	75
1995	Denmark	Gjern	77	53
1996	Sweden	Lökeberg	79	54
1997	Norway	Hankø	88	56
1998	Denmark	Sæby	108	68
1999	Finland	Keuruu	146	92
2000	Sweden	Uddevalla	193	119
2001	Norway	Bergen	259	163
2002	Denmark	Bautahøj	132	92
2003	Finland	Porvoo	223	137
2004	Sweden	Falkenberg	167	115
2005	Norway	Kristiansand	147	92
2006	Denmark	Helsingør	133	77

Table 1. IRIS Conference paper counts by year and location.

There are 1696 papers for all years 1978-2006: these are 1598 single nation (written by one or multiple authors all from one nation designated National in Table 2), 44 Scandinavian collaborations, 54 external international collaborations. Of the 1598 national papers, 1424 are from Scandinavian countries and 174 are from non-Scandinavian countries). Not shown in Table 2, are that 44 papers have joint co-authors of two to four Scandinavian countries. And 54 papers are by co-authors from non-Scandinavian countries, these are external international. The columns for paper counts with Scandinavian authors and international authors cannot be added down, and they will not sum to 44 and 54 respectively, as papers with authors from two or more nations will be listed in multiple rows.

Country	Paper count with all author(s) National	Paper count with Scandinavian author(s)	Paper count with International author(s)
Sweden	574	28	14
Finland	424	16	17
Denmark	232	21	17
Norway	194	22	11
UK	41	13	
Germany	38	5	
Australia	25	5	
Italy	14	5	
USA	13	14	
Others	43		
TOTAL	1598		

Table 2. Paper Count by Country

General network properties are made on the largest connected network component. These are represented in Table 3. Besides the properties defined earlier, we describe several more here. The amount of links, 1066, is the number of co-authorship relationships in the largest connected component. The amount of authors, 541, is the number of unique authors in this connected component. The number 254 of core group members is the number of persons of the connected component that produced 80% of the papers overall. That means of the 1696 papers produced for all years that the ratio of 17.3% of contributing authors produced 80% of the articles. The density of the largest component is fairly high, that is 72% is the ratio of the number of existing links compared to the number of possible links between unique authors. Finally, the average degree is the average amount of contacts per author in the core.

Largest Network Component Properties	
First Article	1978
Last Article	2006
Amount of authors	541
Amount of links	1066
Diameter	15
Core group members	254
Average link-strength	2.41
Density	0.72%
Average degree (contacts)	4.3
Average betweenness	0.99%
Average centrality	18.56%
Average path length	6.38

Table 3: General network properties of the largest network component

Table 4 shows the top ten authors that have contributed the most articles to IRIS. We will display the egocentric network of some of these top authors to give an impression of the interconnection of researchers that they have supported.

Active Period	Author	Author_ID	Paper Count
1983-2004	Lars Mathiassen	ID_58	29
1978-2002	Markku Nurminen	ID_12	23
1978-2006	Pertti Järvinen	ID_4	22
1989-2003	Carsten Sørensen	ID_160	21
1981-2006	Per Flensburg	ID_30	19
1990-2005	Karl Heinz Kautz	ID_187	19
1986-2005	Peter Axel Nielsen	ID_114	17
1997-2006	Lars Svensson	ID_343	17
1994-2006	Urban Nuldén	ID_433	15
1991-2006	Ole Hanseth	ID_213	15

Table 4: Top 10 authors and the number of papers contributed.

Tables 5 and 6 show other top listed individual actor measures.

No	Author	Author_ID	Betweenness Centrality
1	Markku Nurminen	12	31.29%
2	Kristin Braa	1517	23.32%
3	Ole Hanseth	213	18.46%
4	Karl Heinz Kautz	187	17.54%
5	Carsten Sørensen	160	16.69%
6	Lars Mathiassen	58	15.63%
7	Joan Greenbaum	132	15.09%
8	Lars Svensson	343	14.15%
9	Jukka Heikkilä	112	10.16%
10	Jonny Holmström	554	8.46%

Table 5. Actors with the top betweenness centrality measures.

No	Author	Author_ID	Degree Centrality	Co-author Count
1	Markku Nurminen	12	6.64%	36
2	Lars Mathiassen	58	4.61%	25
3	Lars Svensson	343	3.69%	20
4	Carsten Sørensen	160	3.69%	20
5	Ole Hanseth	213	3.51%	19
6	Karl Heinz Kautz	187	3.32%	18
7	Vesa Savolainen	29	3.14%	17
8	Göran Goldkuhl	13	2.77%	15
9	Matti Jakobsson	19	2.96%	16
10	Per Flensburg	30	2.96%	16

Table 6. Actors with the top degree centrality measures.

Tables 5 and 6 show different ways participants have been core or central to the network. Using the Author_ID in Tables 5 and 6 the participants can be identified also in the broad network visualizations.

Figure 5 shows the relationship network among the top 5 central actors of the above listed in Table 6.

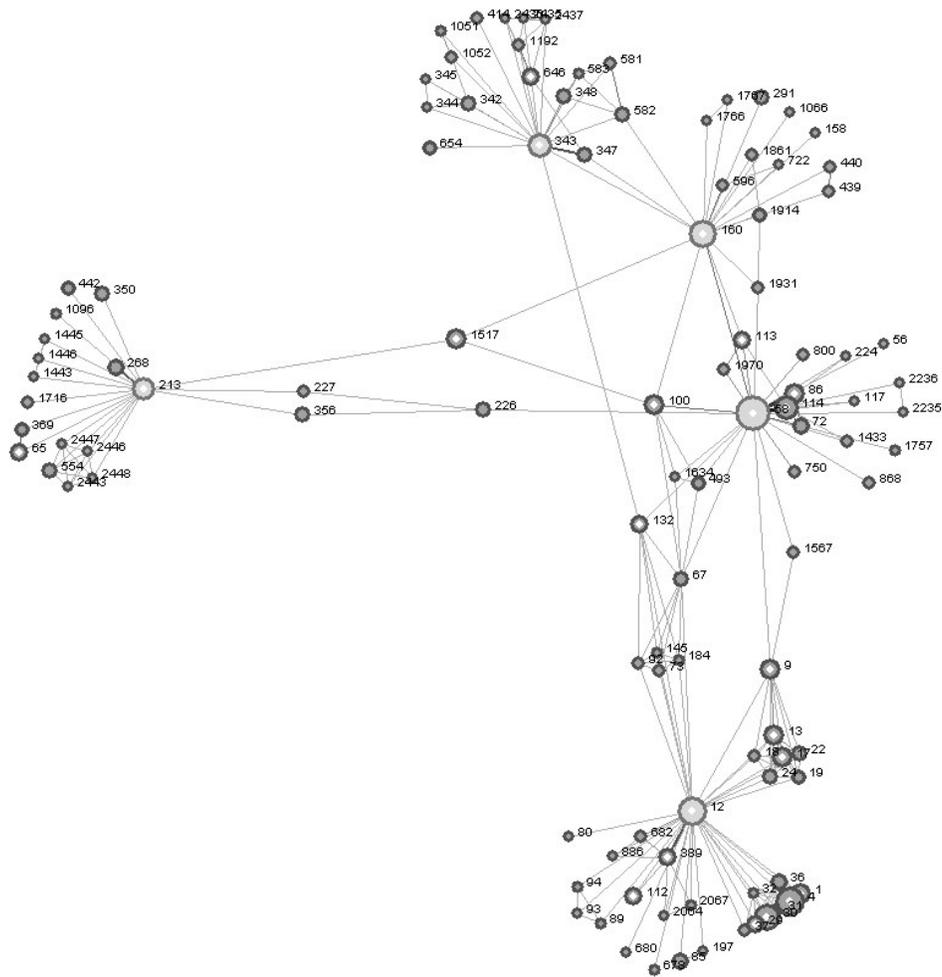


Figure 5. Combined Relationship ego-network among the top 5 central authors (with 107 authors and 248 relationships)

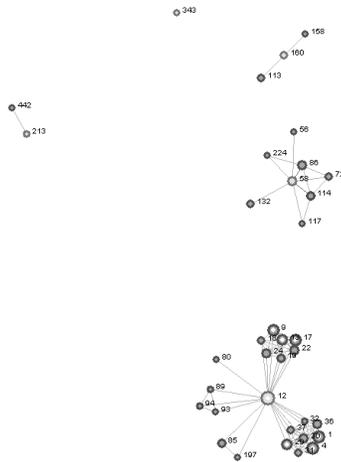
The lighter color nodes in Figure 5 represent the top five central actors selected as ego. Interestingly, four actors of the top6-top10 actors in Table 4 are also found in direct relationship to these top5.

It can be observed, how the combined ego-network forms around initial personal networks of the top 5 actors.

This combined ego-network can also be analyzed for its behavior over time. Figure 6 observes two time periods, the first half until 1991 and the second half of the sampling period. Compared to Figure 4, it can also be seen, that the development of the top 5 central nodes corresponds to the general development of the IRIS network and its shifting epicenters throughout the analyzed four time periods. Node 12 was very central during the first period. Later node 58 moved to the central position in period two. In this period, node 160 was embedded in a very small peripheral component, but it moved towards a very central position in

period three (starting in 1993). The same applies for node 213, except that this author started its centralization efforts later in 1998. Node 343 finally is the most connected node in the fourth period although the first co-authorship link was established only in 1997. For the observed IRIS network, this implies that the active centers of the overall structure are formed by very active and prominent authors during their lifecycle of activity. Although three out of the top five have even collaborated directly, their respective groups of co-authors remain much separated (yielding in a high betweenness of the central actors) and create almost no links among each other, i.e. there is almost no triadic closure effect.

A: Ego-network among Top5 central actors 1978-1991 (36 authors with 87 relationships)



B: Ego-network among top5 central actors 1992-2006 (82 authors with 165 relationships)

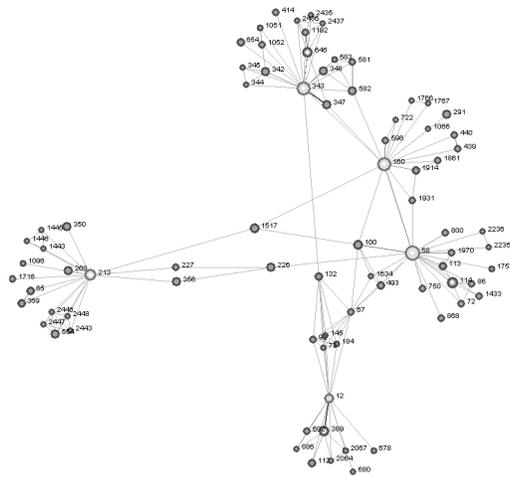


Figure 6. Top 5 key actors and their ego-centric relationships during in two sampling periods.

Keyword Filtering of Words in the Article Titles

Keyword Filtering will enable us to see the influence of themes and topics in IRIS as represented through the frequency of the keyword in the network.

For the list of most prominent terms, similar terms like genitive forms or plurals have been grouped. The following Table 7 lists the most frequently used terms and thus indicates the dominant keywords. We measured the number of participating actors (acts*), which used a certain keyword in a paper.

Term	Occurrences		Term	Occurrences	
	acts*	Rank		acts*	Rank
system	416	1	methods	35	20
information	284	2	practice	35	20
development	221	3	electronic	33	23
design	146	4	theory	32	24
software	109	5	organizational	31	25
knowledge	88	6	quality	31	25
technology	76	7	human	30	27
process	75	8	object	30	27
management	69	9	communication	29	29
computer	64	10	study	29	29
approach	60	11	project	28	31
analysis	56	12	social	28	31
research	54	13	framework	27	33
mobile	53	14	group	27	33
learning	51	15	methodology	27	33
implementation	45	16	cooperative	26	36
support	45	16	improvement	25	37
systemeering	45	16	evaluation	24	38
model	42	19	method	24	38
business	35	20	action	23	40

Table 7. Top 40 Keywords⁴

Measuring the term co-occurrences yields the result that the terms information and system, system and development, software and process, knowledge and management, as well as computer and support, often have been used together in a paper title. This suggests that those terms were used as combined keywords, which gives a first impression of which aspects of Information Systems Research were published most frequently. Table 8 shows keyword co-occurrences.

⁴ Acts*= Contributing Acts is the number of Participants in the co-authored paper with the respective keyword. (e.g. 416 mean that 416 actors participated in a paper using the term “system”).

Co-Occurrence in % Matrix of Top 20 Terms		
Term A	Term B	Terms A and B
information	system	106
system	development	66
software	process	19
knowledge	management	14
computer	support	13
information	development	30
system	design	29
computer	design	11
software	development	15
information	technology	15
process	development	11
development	management	10
system	knowledge	18
system	method	16
system	implementation	15
system	model	15
information	research	11
information	management	10
system	management	13
software	system	14
system	analysis	12
system	research	10

Table 8. Keyword Co-Occurrences

To create a dynamic view of keyword occurrences we split the dataset into time slices with a length of four years. Then the keyword occurrence in each time slice has been counted to check for longitudinal changes in the keywords used. This is shown in Table 9.

Keyword	1978-1981	1982-1985	1986-1989	1990-1993	1994-1997	1998-2001	2002-2005
system	21	46	36	27	10	12	8
information	25	21	14	10	10	11	10
development	11	9	18	15	2	8	9

design	18	9	3	9	9	8	5
software	0	3	1	3	5	9	4
management	0	4	0	3	1	8	6
technology	0	0	6	1	5	3	7
process	1	0	3	1	5	6	4
knowledge	3	4	3	3	1	7	4
method	14	12	2	5	5	2	2
support	0	4	7	2	6	3	3
model	27	4	3	4	0	2	2
computer	0	13	6	4	3	3	1
organization	0	0	6	<1	4	5	1
mobile	0	0	0	0	0	5	5
implementation	0	5	3	0	3	4	3
practice	0	0	1	1	2	4	4
analysis	4	15	6	3	3	<1	1
learning	0	0	1	2	4	2	3
research	13	5	1	1	0	2	2
systemeering	30	1	0	0	0	0	0
PSC	14	3	0	0	0	0	0

Table 9. Development of Keyword Occurrence defined as number of papers with keyword across time in percent of overall papers in that period. Further graphs available via the online supplement at <http://www.commetrix.de/iris>.

Table 9 highlights two temporal effects. First, the share in percent of occurrence of those keywords (i.e. percent of papers with selected keyword versus overall papers) decreases noticeably over time. This highlights reduced coverage of the selected top twenty and indicates increased pluralism and heterogeneity in terms of keywords: over time the main topics differentiate to a larger set of different terms. Quantitatively, the initial 307 detected keywords per four-year-period grow to 855 keywords (with a peak of 998 around the year 2000 after doubling within the preceding four years).

The second observation is that different topics have different lifecycles: The keyword analysis seems to indicate a trend from basic terms like “systemeering”, “methods”, “model”, “analysis” to terms associated with more application of IT like “mobile”, “technology”, or “management”. A third group seems to remain stable, including the core terms “information” or “development”. Both trends suggest, that a general lifecycle of the whole discipline from general issues to more diverse and application oriented issues can be observed here.

To give a visual account of how the keywords spread over time, we observed the two terms ‘information’ and ‘knowledge’ in more detail. The filtered networks of Figure 7 show the co-authorship networks which covered those topics in their papers. It can be seen, how the use of the terms in the papers expanded. These 2 terms are used in the first period. However, the co-authorship network around the term information appeared in 1980, whereas the network around the term knowledge appeared in 1985. The analysis of the usage of the term knowledge further showed that it can be assigned to the context of knowledge engineering. The context of knowledge management became dominant towards the end of the sample period.

A second insight is, that co-authorships using the keyword information grow fairly constant, where as knowledge started to increase its occurrence after the year 1997. The clusters of co-authors using the term knowledge are all rather small, whereas there is a dominant co-author network that used the term information. However, it appears to be a result of very early group formation processes in the first 10 years.

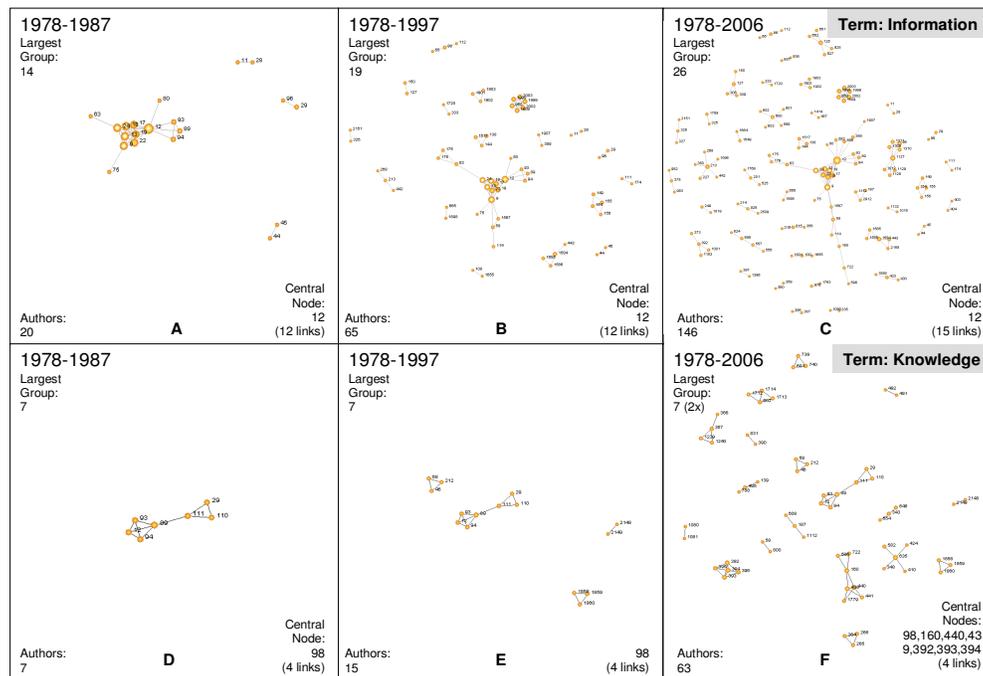


Figure 7. The co-authorship network of authors, who employed the terms information (A-C) and knowledge (D-F) in their papers, indicating the spread of these terms over time (video clip is available at www.commetrix.de/iris)

Interpretation of Results in a Historical Context

Through our approach of visual analysis, we conclude that using information visualization in social network analysis can create transparency on the evolving structures in co-authorship networks. This revealing visual approach allows us to efficiently convey an intuitive impression of the otherwise invisible network – even to users which are unfamiliar to the topic of SNA. We can better identify, explore and present interesting patterns, zones and growth processes within large complex networks. Central authors are not only a list of names, but their role for the network as a focal point of activity, attraction and group formation can be grasped. Dynamic analysis offers opportunities to quickly understand how and when parts of a large network disconnected and rejoined, quickly grew or stalled.

The previous sections have given a visual representation of the co-authorship network in IRIS. If we reflect on this specific network in an historical context, several qualitative interpretations can be made.

The core persons in this study are those who have been active in the submission of articles to the conference. This study however does not tell us about who is central within the Scandinavian school, or research tradition. A valuable extension to this study to place these persons in the larger context would be to identify the citation history of the participants in the conference. So, we may observe in Table 4 that Finnish contributors were very active in the early years, and Swedish actors became more prominent later. But, IRIS activities between countries and faculties do not tell use about activities that took place outside of IRIS.

The 29 years imply significant change for every participant. Juniors become seniors and retire, while some other students leave the academic carrier. The proportion between seniors and juniors has been changing. While again we see the active period of key persons in Table 4, some questions are difficult to evaluate given our present data. For example, are there generations and how did the new generation emerge and at what rate do the old ones leave? These issues would require further data collection and analysis. For example, the date of PhD degree and/or first positions (professor, associate) could be added to the data. We already see indications of such a life cycle in the data of overall network relationships of Figure 4 and in ego-centric relationships of Figure 6. Both of these figures indicate that different authors emerge as dominant over time, that epicenters of activity can be observed and that some indirect paths exist seeding the devolution and emergence of cores of associations.

The social networks do tell us, interestingly, who was writing with whom. It was not surprising to find out that people prefer to write with their colleagues, most prominently with those closest to home. More interestingly, the visualizations reveal the exceptions, collaboration patterns that emerge because of joint activities even over national boundaries. The activities can be independent and unrelated as visualized in Figures 5 and 6. In the whole network graph of

Figure 2, we even see islands, collaborations that are not part of the largest component. What may be the reason for these? We may speculate a local school or department having no contact with others.

The most exciting question that this study begins to answer is what are the key topics of research? We see in Table 9 that keyword terms such as “systemeering” faded out of use after the early years. However, other terms like “information”, “systems” and “development” are still in use today. Overall there are observed a larger corpus of words found in the paper titles and this may reflect a greater diversity of topics in recent years. We are nevertheless left with many open questions. What has changed and is the change reflected in the titles of the papers? Is there a (at least partly) distinct Scandinavian School within IS research? Are there larger groups that have made research in the same areas, methods or approaches, such as collaborations between Gothenburg-Oslo and Copenhagen-Malmö-Lund or VITS network within Sweden? Alas, the keyword-list from papers titles is too limited to draw conclusions on so many questions. Similar methods that were used to incorporate keywords of the title in Commetrix could be used in future research to formulate tables of co-occurrences of citations. That is cited names that appear in the same articles together could be analyzed as keyword terms are in the present study. A preliminary requirement, would be of course to obtain the full text of all the past conference papers.

Finally, one limitation of the current approach to network visualizations is that it is only another form of representation and analytical access to large networks. That is such analysis rarely adds hard statistical facts to our knowledge. As such, visualizations always need to be supported with thorough statistical analysis.

Concluding Remarks

Our analysis points out the importance of a research forum such as the annual IRIS conference. It indicates that a significant network of researcher collaboration has emerged through a very social and productive annual gathering over 29 years. We conclude that IRIS has influenced the research direction in Scandinavia. However, further use of Commetrix and analysis of the IRIS collaborative network is desirable. For example, further visualizations could explore citation relationships in the conference papers, or even the subset of IRIS-authors cited in top journals. While data collection is a daunting task, such an approach would further demonstrate the relatedness and impact of the work begun at IRIS on a larger global community.

References

- Barabási, A.L., Jeong, H., Néda, Z., Ravasz, E., Schubert, A. and T. Vissek, (2002). "Evolution of the Social Network of Scientific Collaborations," *Physica A*, 311, 590-614.
- Brandes, U. (2001). "A Faster Algorithm for Betweenness Centrality," *Journal of Mathematical Sociology* 25(2):163-177.
- Burt, R.S. (1997). "The Contingent Value of Social Capital," *Administration Science Quarterly*, 42(2):339-365.
- DeCastro, R. and J.W. Grossman. (1999). Famous trails to Paul Erdos. *Mathematical Intelligencer*, 21(3):51--63.
- Freeman, L.C. (1979). "Centrality in social networks: I. Conceptual clarification." *Social Networks*, 1, 215-239.
- Goldkuhl, G., (2006). "Collaborative researching – from ISAC to VITS through Humor", In Bubenko J et al (eds) *ICT for people. 40 years of academic development in Stockholm*, DSV, Stockholm University, pp.1-8.
- Grossman, J. W. (2004). *Erdős number*. (Access: <http://www.oakland.edu/enp/>).
- Kerola, P. (1979). "On the extension of the PSC systemeering model" (in Jarvi and Nurminen (eds.), *Report of the Scandinavian research seminar on systemeering models*, 50--54).
- Kerola, P. and P. Järvinen, (1979). "The PSC systemeering model" (in Kerola, Klemola, Kamarainen and Lyytinen (eds.), *Summary report of the systemeering research seminar*, 30--38).
- Kerola, P. and W. Taggart (1980), Human information processing styles and the information systems architect in PSC-systemeering model (in Lyytinen and Peltola (eds.), *Report of the third Scandinavian research seminar on systemeering models*, 95--125).
- Lundeberg, M., Goldkuhl, G. and A. Nilsson (1981). *Information systems development – A systematic approach*, Prentice-Hall, Englewoods Cliffs.
- Molka-Danielsen, J. and Sjøvik, B.L.B., (2005). "Direction of Links in Collaborative Research Networks and Other Structural Characteristics", *Proceedings of the 28th Information Systems Research Seminar in Scandinavia*, eds. Eli Hustad, Bjørn Erik Munkvold, Knut Rolland, and Leif Skiftenes Flak, paper number 32, Kristiansand, Norway, August 6-9. ISBN: 82-7117-554-8.
- Newman, M. (2001). "Clustering and Preferential Attachment in Networks," *Physical Review*, E64, 25102.
- Nurminen, M.I., (1997). "Nurminen's Column on IRIS: Part 1," *Scandinavian Journal of Information Systems*, 9(2):47–52.
- Taggart, W. (1980). "Human information processing styles and the information systems architect in the PSC systemeering model", *Proceedings of the 17th annual computer personnel research conference*, p.63-78, June 26-27, Miami, Florida, United States.
- Trier, M. (2005). "IT-supported Visualization of Knowledge Community Structures", *Proceedings of 38th IEEE Hawaii International Conference of Systems Sciences HICCS38*, p.194-202, January, Big Island, Hawaii, United States.
- Wasserman, S., and K. Faust (1994). *Social Network Analysis: Methods and Applications*. Cambridge, England: Cambridge University Press.

Appendix

A description of measures used by Commetrix

Metric (per author)	Commetrix	Wasserman/Faust 1994
Direct Contacts	$DC(n_i) = d_i$ $d_i :=$ number of direct contacts of actor i Co-authorships of actor i	$DC(n_i) = d_i$ $d_i :=$ number of direct contacts of actor i
Betweenness Centrality	$C'_B(n_i) = \frac{\sum_{j=1}^g g_{jk}(n_i)}{\sum_{j=1}^g g_{jk}}$ <p>→ standardized value of $C_B(n_i)$</p> <p>There might be more than one shortest path between actors j and k.</p> <p>$g_{jk}(n_i) :=$ Boolean value if there is a shortest path between actors j and k over actor i (j and k distinct from i). $\{0,1\}$</p> <p>$g_{jk} :=$ Boolean value if there is a shortest path between actors j and k. $\{0,1\}$</p> <p>Number of shortest pathes between all pairs of actors j and k (not including actor i) over actor i.</p> <p>Standardized by the number of all shortest pathes in the network.</p> <p>Only one shortest path between</p>	$C'_B(n_i) = \frac{\sum_{j=1}^g g_{jk}(n_i)}{\frac{(g-1)(g-2)}{2}}$ <p>→ standardized value of $C_B(n_i)$</p> <p>There might be more than one shortest path between actors j and k.</p> <p>$\frac{g_{jk}(n_i)}{g_{jk}} :=$ probability of shortest path $g_{jk}(n_i)$. All pathes equally likely. If only one shortest path exists value is 1.</p> <p>Number of shortest pathes between all pairs of actors j and k (not including actor i) over actor i.</p> <p>Standardized by the number of pairs of actors not including n_i.</p> <p>All shortest pathes between</p>

	<p>actors j and k is taken into account.</p> <p>Shortest pathes are calculated by the Floyd Warshal Algorithm.</p>	<p>actors j and k are taken into account.</p>
Degree Centrality	$C'_D(n_i) = \frac{d(n_i)}{g-1}$ <p>→ standardized value of $C_D(n_i)$</p> <p>$d(n_i)$:= number of direct contacts of node i</p> <p>g := number of actors</p> <p>→ $g-1$:= maximum number of direct contacts</p> <p>Standardized, relative measure of direct contacts</p>	$C'_D(n_i) = \frac{d(n_i)}{g-1}$ <p>→ standardized value of $C_D(n_i)$</p> <p>$d(n_i)$:= number of direct contacts of node i</p> <p>g := number of actors</p> <p>Standardized, relative measure of direct contacts</p>

How to Study the Context of Information Systems

Tuija Tiihonen

University of Kuopio, HIS R & D Unit, P.O. Box 1627,

FI-70211 Kuopio, Finland

tuija.tiihonen@uku.fi

Abstract

Information Systems (IS) are socio-technical systems; they should be considered as an entity of people working together and using technology. In the field of IS research, the gap between the realization of IS in a social context in its everyday use and the theories and plans of IS implementation is acknowledged, but little research has been conducted to fill this gap. Thus, more research in this area is needed. The concept of social context is widely studied among anthropology and social sciences, but the context of modern sociotechnical IS cannot be considered directly by those fields of study. In this paper, we describe a research methodology to build a framework for mapping contextual factors of IS use in organizations. The framework is meant to be used by IS developers to create appropriate, sustainable and usable information systems.

Keywords: Information system, context, information system research, socio-technical system

1 Introduction

Information Systems (IS) are almost as old as mankind. They have existed as long as human beings have shared information, and the social development of human kind can be seen as a result of successful information systems. Yet, the nature and context of information have changed considerably in different environments throughout the course of history, and humankind has increasingly developed technology, tools, and methods to manage information. IS are certainly not modern innovations. However, along with the present world's high technology information solutions, the concept of IS is typically perceived to be systems where information is used, collected, stored, and shared via electronic tools, such as computers. The information and communication technology (ICT) and computer based IS is becoming more important for everyone globally (Heeks 2002, Moyi 2003, Walsham et al. 2006, WITFOR 2005). Although IS are old, these computer based IS are relatively new contexts and not generally studied yet.

With previous research in Information System Development (ISD), the need for context-sensitive methods is shown several times. The literature is overloaded with reports of ISD failures (Walsham 2000; Furuholm & al. 2006), while the few success stories support the fact that the sustainable IS and appropriate ISD need context-aware human resources, i.e., local experts who know the domain, the culture, and the local working habits (Lai et al. 2003, Rohitratana 2000, Krishna et al. 2005). In the field of IS research, the gap between the realization of IS in a social context in its everyday use and the theories and plans of IS implementation is acknowledged. The failures in ISD are too common, and very often, the reason for this is a pervasive ignorance of the social context. A recognized need exists for methods for utilization by IS developers to evaluate the features of different IS contexts. Still, in Computer Science (CS) and ISD, context studies are not focused on producing theories, frameworks, or methods to observe the working environment but more on the technical and economical aspects of ISD. Therefore, the need for sociotechnical context research remains (Avgerou et al. 2004).

This research is part of the long-term INDEHELA (Informatics Development for Health in Africa) research program (Korpela et al. 2006). The overall objective is to attain better service to

communities through better IS methods and better IS education. Within this program, knowledge about ISD methodologies and practices in Sub Saharan Africa (SSA), mainly in Nigeria, is produced (Mursu 2002, Soriyan 2004). The objective of the present phase of the INDEHELA is to focus on the sociotechnical context of IS and to develop a framework to be used for the evaluation of the IS context. The main research problem is recognition and characterization of contextual factors that affect IS development and use. How would these factors be found? What are these factors like? How can the factors be utilized in the evaluation of IS use and development? But before developing such a framework, the most fundamental question is: What exactly *is* information system context?

The concept of context is huge, complex, and very difficult to define or explain. In different fields of science there are several descriptions of context, but the context of IS as a sociotechnical system is not described. The idea of ICT based IS social context existence is not very old. In very recent publications, Pettigrew (1985) elucidated the idea of contextualism in IS. Whether the IS context considers the ethnomethodology approach has been quite influential, and the context is described as a series of actions between technology and human, not including the environment (Räsänen & Nyce 2006). Context in CS is considered as more in the form of technical design challenges, such as sensor fusion, information management, and system parameterisation (Dourish 2004).

All descriptions of IS context are simply ambiguous, and the methodology to study sociotechnical IS contexts does not currently exist. Specification of IS context seems to be very difficult; consequently, the research of IS context will not be simple either. In this paper, we describe methodology that we have used to approach the concept of IS context with the intention to clarify the definition of IS context and suitable means to study it. Figure 1 shows the cloud of our IS context research and the elements which have entered the research thus far.

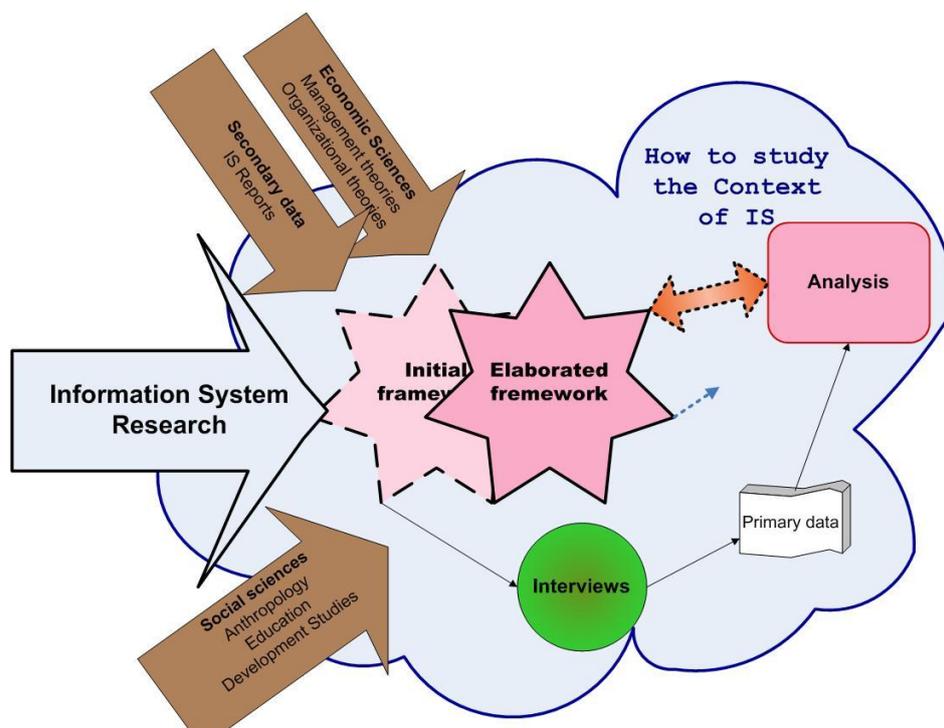


Fig. 1 The elements of the IS context study thus far

The sections of this paper follow the chronological progress of the research illustrated in Figure 1. The cloud in the figure symbolizes the research, and the arrows on the left are "inputs" from

different sources, the most important being the existing IS research. The dashed line star illustrates the first framework that we constructed prior to the interviews, which are symbolized by the green ball. From the interviews, we collected the primary data, which was then analyzed. The arrow between the analysis and the second star, the current elaborated framework, goes both ways from the analysis to the framework and then again back to the analysis. This symbolizes that research is iterative, and the framework will develop as we have analyzed more primary material. The little blue arrow from the elaborated framework illustrates the future use of this framework, testing it in different situations, and using it to assess contextual factors in ISD and implementation.

In section two, we describe the three phases to study the concept of context. As mentioned earlier, in the field of IS, the existing material is quite limited, and the phase one for this research practically began with the definitions of context in the economic and social sciences, particularly the anthropologist's three levels of context. Also, we had original reports from our research partner's IS study in the South African Health Information Systems (HIS), which helped to outline the research area. On the basis of this secondary, we built the initial framework, which in this phase constituted the already existing 2X4 IS-analysis levels model of Korpela et al. (2001), the bowl-model of context scopes, and the categories of context. After this we started the second phase, the gathering of primary data. We used the initial framework to construct the questions for the interviews. We gathered primary data mostly in health care organizations in Finland, South Africa, and Mozambique. Some of this material is analyzed, the current results of this research, phase three, are presented as the "elaborated framework". The primary data analysis continues, and as we analyze more material, the IS context framework will be further refined. Finally, in section three we assess how are we reaching the objective, what is the current state of this research, did we get what we wanted, and the future as this research continues.

2 Research Approach

This research considers the IS context in organizations as a sociotechnical system, which involves both the technical and the human side. While the positivist approach to the context would expound it as a stable feature of the world independent of the actions of individuals (Dourish 2004), IS context in this research is a dynamic entity including the technology, environment, people, and the moment when a person uses the IS. No context can be described as a monolithic, stable whole, but still some features can be recognized, are essential to the context, and are usable in the ISD and use design.

This is phenomenological research of sociotechnical contexts, which aims to find essential features in IS context and build up a framework. This is not actually interpretive research because we are not interpreting the results per se. Rather, the aim is to identify similar and different factors, not to evaluate whether they are good or bad. Nor is this connected to contextual design, which is a user centred approach to the design of ICT systems, which intends to obtain a deep understanding of the work inside the system. On the contrary, the aim of this research is to build evaluation models to be utilized in different IS contexts, not to understand but to detect the immediate context and define it as neutrally as possible. Thus, the material has to be collected from many different kinds of organizations in western and developing countries and from their IS users in different levels, including the senior management to the field level. The preoccupation with these in this phase is neither realistic nor practical.

2.1 Phase one: Literature Review and Initial Framework

The theoretical basis and construction of the initial framework is described in detail on our previous article *Creating a Framework to Recognize Context-Originated Factors in IS in Organizations* (Tiihonen et al. 2006), in this paper we describe the progress of the study thus far. One of the theoretical starting points in the beginning of this study was **the 2X4 IS analysis level model** by Korpela et al. (2001). It is a usable model to limit the view and choose the level of the analysis. Originally, it was designed for the analysis of levels of work activities, but it is also usable when analyzing other IS features, such as levels of knowledge or decision making. In this case, the model helped to focus the level of this research. The most essential is the organizational level because that is the determinant for the IS, but the primary material should be gathered on as many levels as possible to obtain the picture of which kind of situations people use IS and what is their context. Figure 2 displays the modified model. The original idea remains the same, and only the visual picture of this has changed, and Figure 2 includes also the global level, which is not pictured in the original.

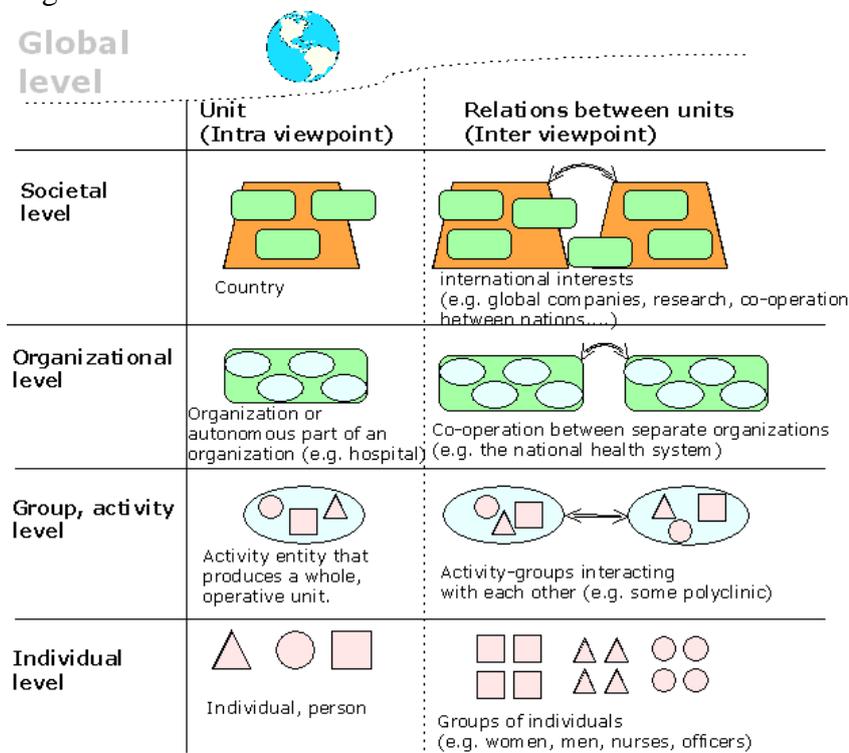


Fig. 2 The levels of IS analysis (Tiihonen et al. 2006 Modified from original Korpela et al 2001)

To outline the character of the IS context, we studied the definitions of it in many fields of science. Among quite a number of different context definitions, the anthropologist's definition of three context levels, cultural, historical, and immediate context, (Tapaninen 2005) seemed to be very appropriate for our research. With this definition, we built **the bowl model of contexts scopes** (Figure 3), which pictures context as water in a bowl where no lines can exactly be drawn between the levels. However, at the bottom of the three anthropological levels of contexts, we have added *nature*, which is quite essential from the view of ISD. For example, the solutions in +38°C must be different than in -38°C temperature climate.

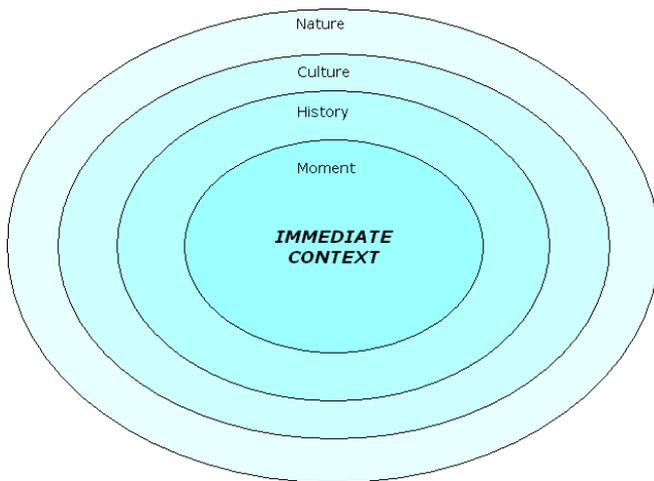


Fig. 3 The scopes of context (Tiihonen et al. 2006)

Nature is the environment that must exist before any kind of culture can appear. Where humans made culture, *cultural context* exists. Cultural context includes all creatures, habits, ideas, norms, values, and beliefs of people. Above cultural context is the *historical context*, which refers to all of the historical events that marked its cultural context. The innermost 'top' context is the *immediate context*, which is the entire physical and social environment, its actions and interactions, the actors and roles, and everything that surrounds the moment. The immediate context in the use of IS is not studied as a separated feature surrounded by stable elements. On the contrary, all the scopes of the contexts in their different forms are influencing dynamic change to the immediate context.

One remarkable source of secondary data was the **situation analysis reports** that we received from our HISP (2007) partners in South Africa, which were conducted in different health care (HC) organizations in order to map their information systems. With the help of these reports, the picture of the research area began to take form, yet all the existing literal material is focused on some other reason than describing context; it can only help to create some guidelines, not work as a research material itself.

Several environmental **categories of factors** have an influence on the context of IS. In the beginning, we delineated five main categories: *socio-political environment, infrastructure, organization culture, economy, and human resources*. The selection of these categories is based on the findings in literature (Ciborra 2004, Lai et al. 2003, Molla et al. 2005, Mosse 2005, Soriyan 2004), and our own work and research experiences in information systems. The nature and the priority of these have elaborated along with the research. These categories are illustrated as sectors on the contextual scopes (Figure 4), and the free space between them describes the other areas or categories that exist but are not in our interests.

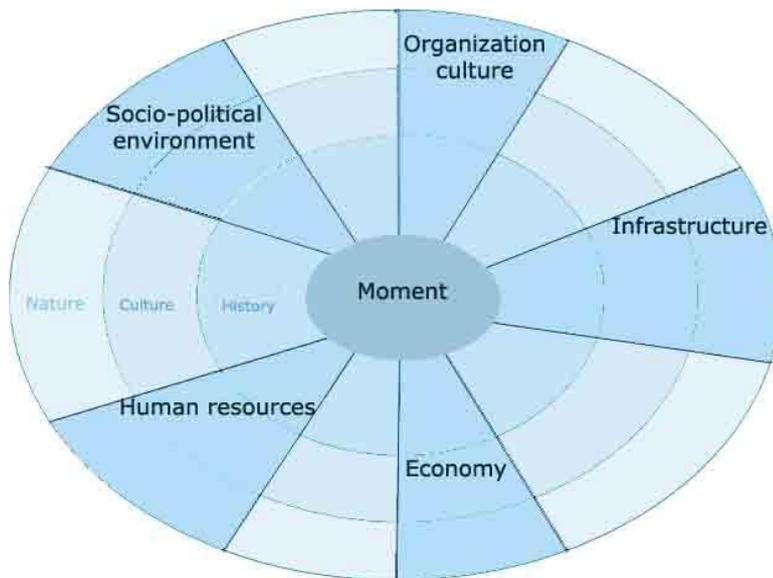


Fig. 4 The categories of context (Tiihonen et al. 2006)

On this basis the analysis of the nature of IS context was started, and the research of the huge mysterious concept of IS context began to take form. We had a basis to start to collect primary data and a framework that we could use to help focus the issues, which might be essential when constructing the interviews, although we could not be sure what kind of material we would get from the interviews.

2.2 Phase Two: The Interviews

The objective of this research is to study information system use, so the primary data from the IS users is compulsory. To achieve as diverse data material as possible, the material should be gathered in different western and SSA countries, from as many as possible organizational IS, and from different levels of the organization. The focus is on health care organizations, but to reflect the results, we also needed to include other organizations. Currently we have primary data from Finland, South Africa, and Mozambique from various types of organizations. The resources to gather the material are limited; no resources are available for a longer stay in Africa or to travel there often. Therefore, the methods to collect primary data in this research are mainly by interview and conversation. The primary data is collected from Finland, South Africa, and Mozambique during the years of 2005 and 2006.

First, we had to decide what kind of factors we were looking for. The context of organizational IS is quite large, and there were neither certain questions nor right answers. Again, the information system is a human system, and the reality for every individual is different. To build an interview we used the five categories (infrastructure, economy, socio-political environment, human resources, and organization culture) and created questions that fit a certain category.

The interviews started in October of 2005 in Kuopio University Hospital, Finland. Our INDEHELA partners at the South African institutions of Cape Town University and Cape Peninsula University of Technology and at the Mozambique institution of Edouardo Mondlane University arranged opportunities to conduct interviews in their countries. In November of 2005, we had conducted 12 interviews altogether. Some of these were group interviews, the number of interviewees is altogether 24. The interviews began in Cape Town where we met IS users, system developers, and administrative people in private and in public HC organizations. Then we went to rural area health

care organizations and conducted interviews in Wredenburg private and public hospitals. After that, we travelled to Mozambique where we made interviews in Manhiça telecentro, Manhiça Health Research Centre, Central Processing Centre CDP and the Bank of Mozambique. In April of 2006, the interviews continued in Finland where we met some home care nurses and their superiors in a public HC organization in Sotkamo, Kainuu in the northern Finland rural area.

We started the interviews with the following question sectors: 1) *Basic Questions* (name, age, etc.), 2) *Work* (working title, role in the organization, etc.), 3) *Technology* (availability of technology), 4) *Motivation*, 5) *Environment and Infrastructure*, 6) *Hierarchy*, and 7) *Human Relations in the Working Environment*. The structure of the questions was quite strict, and a detailed question series for all of these groups was utilized. Some questions included word lists (see appendix A), which were shown during the interviews, and the interviewees were asked to tell their opinions about the words or relate other affairs that come to mind with the topic of the list. There were four different lists: A list of the tools used for information gathering in work, list of facts that are important to a person in a leadership position, and corresponding list of features of people that one is working with. The most interesting comments were gathered from the list of items that might threaten the functioning of the IS, which is a collection of threats from different reports and articles mostly from the field of IS risk management. On average, the individual interviews lasted 45 minutes, and the group interviews lasted 60-90 minutes, all of which were recorded.

The strict questions were quite functional in Finland, but during the first interview in South Africa, we realised some important cultural differences. The South African people like to talk on great detail. Therefore, every detail does not have to be asked separately, and after the first interview in Africa, the strict questions were combined to wider, more thematic questions. As the interviews progressed, we omitted the questions that always included some kind of supposition. Instead of questions, we used word lists. The neutral list provided the interviewees free space tell what they really thought. The viewpoints, values, and meanings of the words arise from their own reality. The interviewer(s) could ask defining questions when needed. This method seems to be appropriate in this kind of research where neither straight answers nor even straight questions exist.

2.3 Phase Three: Results, the Elaborated Framework

Based on the literature review, secondary data and the interviews we have been, we have been able to illustrate the context of IS in the following figures. Figure 5 displays the contextual categories and their relationships as we see them now, and Figure 6 displays the categories from the view of immediate context. Although the names of some categories have changed slightly, the original idea has remained quite constant. Instead of economy and infrastructure, we used more extensive terms for financial and physical resources, and instead of organization culture, we looked at the organization as a whole where IS is an important component.

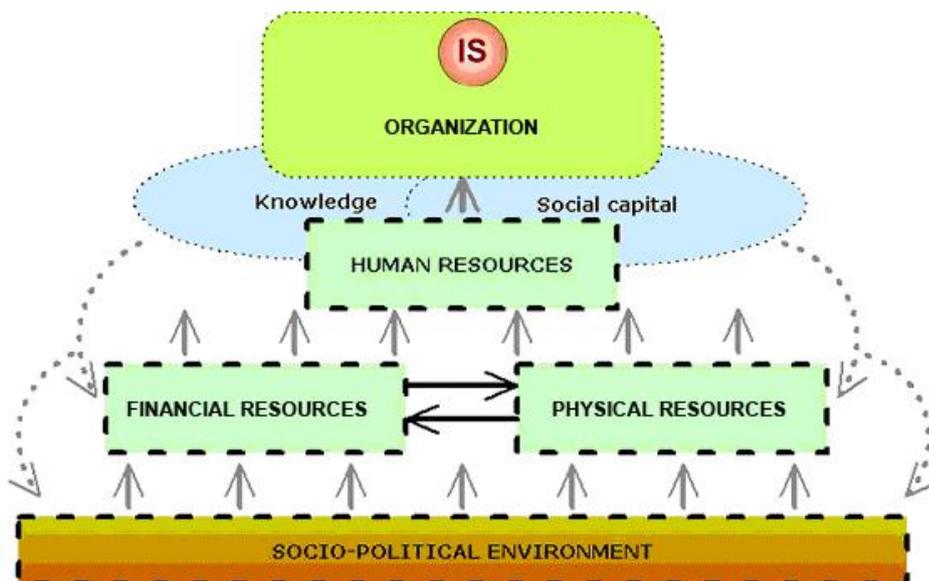


Fig. 5 The categories of society which influence the IS context inside organizations

All of the five categories are related to each other and cannot exist without each other. In Figure 5, the bottom is the socio-political environment, which is the basis for everything. It is the basis of action and transaction in society, and it provides possibilities for the existence of sustainable social, technical, and economical activities. If the socio-political environment is not stable, the other categories still can and do exist, but their opportunities to develop are significantly weaker than in a stable environment. Next, financial resources and physical resources are on the second level. They are in close relationship with each other. High infrastructure is needed to stimulate development in the economy, and economical resources are requisite to obtain and maintain high infrastructure and technical development. Human resources are on the third level, which is the core of development resources. Important parts of human resources are the knowledge itself in different forms and the knowledge as a social capital. The relationship of human resources to other categories is quite clear; actually no other category can exist without human resources. Thus, financial and physical resources create potentiality to develop human resources, whereas the human resources are inevitable to maintain and develop financial and physical resources and the socio-political environment. Finally, on the top of Figure 5 is the organization, the immediate environment of IS, the IS context. All the action and interaction of other categories is realized in the organization, and organizations need every other element in the figure to be able to exist. Additionally, different kinds of organizations are the core of sustainable, stable, and developing society. Every organization must have an information system to continue communication for action and transaction. IS gathers, transports, and stores the information required in the organization; it is the entity of knowledge, data, and information moving inside the organization and in and out to the environment. Information is needed everywhere in the organization. IS appears where action or interaction exist. If disorder occurs in information circulation, the organization's functioning is interfered. The IS is also a political question. The hierarchy and technology of IS, who has access to information, and which tools they have is defined by the combination of the structure and culture of organization.

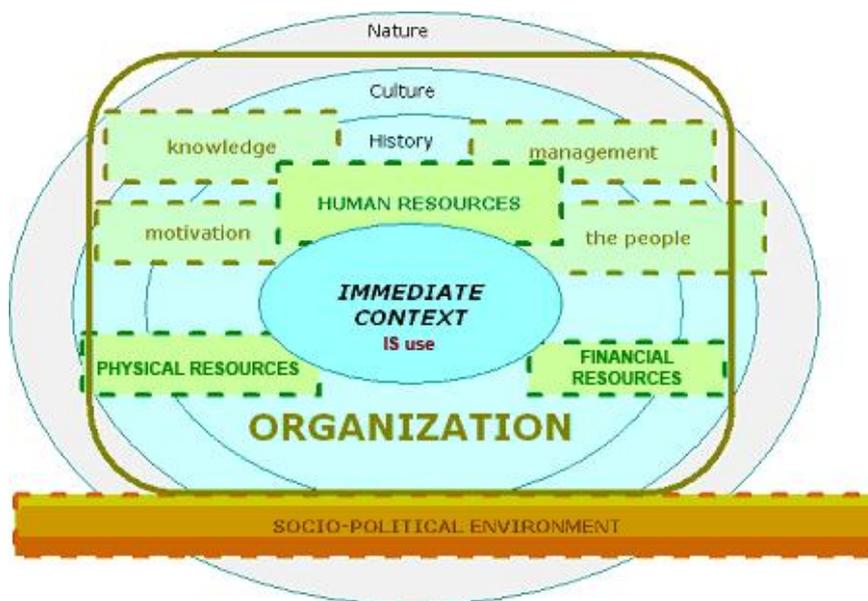


Fig. 6 The contextual categories from the view of immediate context

Figure 6 illustrates the immediate context of the IS use in an organization and the resources which have a direct affect on it. After the interview analysis, the human resources seem to have the most important influence on the IS contexts. Accordingly, poor infrastructure and lacking financial resources are accepted as obligatory facts, but among the human resources is seen several factors which can improve or dilute the IS use context. Knowledge in its different forms, the management and feedback abilities, the people, and the social working environment were mentioned repeatedly as essential parts of motivation. Most of these interviews were made in the HC sector, and the values there differ from the values of the employees in other business sectors, e.g., a software development company. The analysis is still incomplete, but currently these pictures seem to be quite adequate to describe the concept of IS context. However, some modification will presumably be required.

3 Conclusion

As no exact theories or models existed in this area, the research had to begin from scratch: *what is the IS context?* The research predominantly involved gathering and testing the suitable material and building the relations and priorities rather than strict analysis. Consequently, the results are more indicative than exact facts. The aim of this research is to create models, not to find answers or facts.

So far the framework of context models have exhibited some positive aspects as well as some imperfections. They appear to be quite useful and at least worth further development. The framework seems to work quite well in pointing out some factors that were already familiar prior to this new light. This kind of finding supports one of the objectives of the framework: how to find the "obvious things", the ordinary in the IS. In the interviews, the same issues were discussed, but the answers varied considerably. People in different organizations and from different statuses emphasized different things that were important to themselves. However, when the answers - no matter how different they might have been - were analyzed with the framework, they seemed to follow a clear order as means of their situation in the category or scope of context. Naturally some factors cannot be situated in one category only, e.g., the data collection tools. Are they part of technological or economical resources? Maybe the categorization of them is clearly based on the

organizational culture. On the other hand, they can also be a reflection of the socio-political environment much like the human resources. Consequently, the framework may help to find and classify some factors, but it does not provide unambiguous results. With regards to the fundamental question of what is IS context, we do not have an exact answer yet, but we have been able to picture the form, some elements, their relationships, and value to the IS users.

Furthermore, to avoid the bias caused by our own cultural view, we need to obtain research partners in different countries to perform the analysis and testing of the framework in as many environments as possible. The result would mean that the basics of the framework should be usable in every environment. However, at the same time, the framework should be environmentally sensitive to help canvas the essential factors of the context. Thus far, the results have been promising, the framework seems to be usable, and it is used also in the evaluation of e.g. training courses. However, it has been used only in research analysis, but it should be appropriate to utilize this as a tool in the design and implementation of systems. We need experience in the usability of this framework in IS implementation and design. The framework of three context models presented in Figures 2, 5, and 6 is not carved in stone, and it does not have to be used as an inseparable series of models. It is living frame where the usable parts can be picked up case-specifically. Furthermore, much of the gathered material still needs to be analyzed. As we continue the analysis, we develop the framework of the models, and its utilization in IS design and use practises.

References

- Avgerou et al. 2004 Avgerou, Chrisanthi; Madon, Shirin: Framing IS studies: understanding the social context of IS innovation. *The Social Study of Information and Communication Technology*. Chrisanthi, Ciborra, Land (ed.)Oxford University Press 2004
- Ciborra 2004 Ciborra, Claudio: Encountering Information Systems as a Phenomenon. In: Avgerou, Ciborra, Lang (eds.) *The Social Study of Information and Communication Technology*, (Oxford University Press 2004) pp. 17-37
- Dourish 2004 What do we talk about when we talk about context. *Pers Ubiquit Comput* (2004)8. pp. 19-20
- Furuholm & al. 2006 Furuholm, B; Ørvik, T. U: Implementation of Information Technology in Africa, *Information Technology for Development*, Vol. 12 No 1. Wiley Publishers 2006. pp 45-62
- Heeks 2002 Heeks, R, Failure, Success, and Improvisation of Information Systems Project in Developing Countries, *Development Informatics*, WP series, Paper No. 11, (Institute of Development Policy and Management, Manchester 2002) <http://unpan1.un.org/intradoc/groups/public/documents/NISPAcee/UNPAN015601.pdf> (March 16, 2006)
- HISP 2007 The homepage of HISP (Health Information Systems Programme), University of Oslo, <http://www.hisp.org>

- Korpela et al. 2001 Korpela, M; Mursu, A; Soriyan,H. A: Two Times Four Integrative Levels of Analysis: A Framework. In: Russo NL, Fitzgerald B, DeGross JI, (eds.) *Realigning Research and Practice in Information Systems Development. The Social and Organizational Perspective*. IFIP TC8/WG8.2 Working Conference, Boise, Idaho, USA, July 27-29, (Boston: Kluwer Academic, 2001) p. 367-377
- Krishna et al. 2005 Krishna, S; Walsham, G: Implementing Public Information Systems in Developing Countries: Learning From a Success Story.*Information Technology for Development*, Vol. 11 No 2 (Wiley Publishers 2005) pp 123-140
- Lai et al. 2003 Lai, S-Y, Heeks, R, and Nicholson, B: Uncertainty and Coordination in Global Software Projects: A UK/India - Centred Case Study, *Development Informatics*, WP series, Paper No. 17.(Institute of Development Policy and Management, University of Manchester 2003) http://www.sed.manchester.ac.uk/idpm/publications/wp/di/di_wp17.pdf (March 13, 2006)
- Lai et al. 2003 Lai, S-Y, Heeks, R, and Nicholson, B: Uncertainty and Coordination in Global Software Projects: A UK/India - Centred Case Study, *Development Informatics*, WP series, Paper No. 17.(Institute of Development Policy and Management, University of Manchester 2003) http://www.sed.manchester.ac.uk/idpm/publications/wp/di/di_wp17.pdf (March 13, 2006)
- Molla et al. 2005 Molla, A; Loukis, I: Success and Failure of ERP Technology Transfer: A Framework for Analysing Congruence of Host and System Cultures, *Development Informatics*, WP series, Paper No. 24, (Institute of Development Policy and Management, Manchester 2005) http://www.sed.manchester.ac.uk/idpm/publications/wp/di/di_wp24.pdf (March 16, 2006)
- Mosse 2005, Mosse, Emilio: *Understanding the introduction of computer-based health information systems in developing countries: counter networks, communication practices and social identity, A case study from Mozambique* Doctoral dissertation. University of Oslo 2004
- Moyi 2003 Moyi, E. D, Networks, Information and Small Enterprises: New Technologies and the Ambiguity of Empowerment, *Information Technology for Development*, vol. 10 No 4 (IOS Press 2003) pp. 221-232
- Pettigrew 1985 Pettigrew, A: Contextualist Research and the Study of Organizational Change Processes. *Research Methods in Information Systems*, E. Mumford, R. Hirschheim, G. Fitzgerald, and A.T. Wood-Harper, eds., North Holland, Amsterdam.
- Räsänen & Nyce 2006 Räsänen, M; Nyce, J: A New Role for Anthropology? - Rewriting "Context" and "Analysis" in HCI Research. *NordiCHI2006*, 14.-18. October, pp. 175-184

- Rohitratana 2000 Rohitratana, Kaewta: The role of Thai Values in Managing Information Systems. In Avgerou and Walshan (eds.) *Information Technology in Context - Studies from the perspective of developing countries*. Ashgate, Wiltshire 2000. pp.23-39
- Soriyan 2004 Soriyan, H. A: A Conceptual Framework for Information System Development Methodology for Educational and Industrial Sectors in Nigeria. Dissertation. Obafemi Awolowo University 2004
- Tapaninen 2005 Tapaninen, A-M: Sosiaaliantropologian perusteet, *Homepage of Helsinki Open University*. <http://www.avoin.helsinki.fi/Kurssit/sosAntr/materiaali/> (4.5.2005). [Course material, in Finnish]
- Tiihonen et al. 2006 Tiihonen, T; Mursu, A; Korpela, M: Creating a Framework to Recognize Context-Originated Factors in IS in Organizations. Jacques Berleur, Markku I. Nurminen, and John Impagliazzo, (eds). *Proceedings of the 7th International Conference 'Human Choice and Computers', IFIP-TC9 'Relationship between Computers and Society'*, Springer Science and Business Media, 2006. pp. 367-379
- Walsham 2000 Walsham, Geoff: Globalization and IT: Agenda for Research. In Baskerville, Stage, and deGross. (eds.) *Organization and social perspectives on information technology: IFIP International Working Conference on the Social and Organizational Perspective on Research and Practice in Information Technology (TC8 WG8.2)*, 9-11 June, Aalborg, Denmark. Kluwer, Boston 2000
- Walsham et al. 2006 Walsham G, and Sahay, S, Research on Information Systems in Developing Countries: Current Landscape and Future Prospects, *Information Technology for Development*, Vol. 12 No 1 (Wiley Publishers 2006) pp 7-24
- WITFOR 2005 IFIP World Information Technology Forum, Gaborone Declaration 2005, <http://www.witfor.org> (December 2, 2005)

Appendix A: The wordlists used in the interviews 2005-2006

Note: The lists are composed on literature basis (e.g. IS risk management and organizational culture), but also "ad hoc" items which have appeared on the road working inside IS and developing them. Apologies for the poor language. These lists are only to have something to start with, the interviewees were free to talk whatever issues were important to them. In most cases the most interesting opinions and thoughts of the interviewees were just the issues outside these lists.

List of threats:

Which facts can disturb the functioning of the system?

- a) Blackout, power failure?
- b) Diseases, ill health, epidemics?
- c) Too little employees, caused some other reason than illnesses?
- d) Lack of education, there is not qualified labour available? There is not suitable education available here around?
- e) Incompetent management? Management lacks some viewpoints, or skills?
- f) Conflicts between people of the system? Ill-assorted, mismatched people?
- g) Failure or malfunction of the hardware or software, or other machinery?
- h) Lacking training for the new technology?
- i) Political situation, (considering government, national changes; some industrial actions like strikes or something; riots or other trouble)
- k) Nature (the weather, humidity, heat/cold, earthquake, something else..?)
- j) Criminals: Robberies, thefts, hacking to the system, other criminality?
- l) Arbitrary rulers or officers, corruption?
- m) Economical problems?
- n) Untrustworthy employee?

List of tools:

What kind of tools do you use when collecting/sharing/storing data?

- a) Pencil and paper
- b) Telephone
- c) Copy-machine
- d) Typewriter
- e) Computer
- f) Personal contact, discussion
- g) Other tools, which

List of leadership facts:

Which of these facts are important to a people in a leading position

- family, relatives
- wealthy, property
- Education
- Work experience
- authority
- political relations
- Human relations skills
- gender
- age
- good physical condition

List of workmate facts:

Which of these facts are important to a people you are working with, the other members of the system?

- ability to co-operate
- family and relatives
- reliability
- professional skills
- kindness
- political background
- religiosity
- education
- gender
- punctuality
- friendship also over working time

Utilizing Text-Mining Tools to Enrich Traditional Literature Reviews. Case: Digital Games

Johanna Bragge and Jan Storgårds

Helsinki School of Economics, Department of Business Technology, ISS

johanna.bragge@hse.fi; jan.storgards@hse.fi

Abstract. In contrast to the many technological developments of the last ten years that have shaped also the researchers' key tasks, the literature reviews have not diversified much from their traditional forms. This is somewhat surprising given that the manual scan of journals and copying of selected articles in the university library have transformed into an online discovery in various full-text and bibliographic databases. What is more, there are several insightful text mining and information visualization tools that have been developed to help the researcher in profiling, mapping and visualizing knowledge domains. The purpose of this paper is to demonstrate by way of an example the potential of a new approach called *research profiling*, and to raise discussion about the method's applicability in enriching traditional literature reviews. The specific topic of interest in this paper is digital games research as indexed in the ISI Web of Science. Altogether 2.136 articles were profiled. Almost half of the digital games research were classified either under computer science or psychology, or their subcategories. Only a small subset of the research was conducted from a business or management school perspective, which points to an obvious gap in the literature.

Keywords. Literature reviews, research profiling, text mining, digital games, computer games, video games.

Introduction

Each time when starting a new research venture, one is confronted with the task of searching, reading and reviewing the relevant literature. Sometimes this task becomes larger than life in the mind of the researcher, and its beginning is

postponed until the right state-of-mind turns up. Other times, the researcher may be even too enthusiastically carried away with the search and perusal process, as new and more exciting references are listed in every piece of research found. Naturally, these two cases are just extreme examples what might happen. However, in contrast to the many technological developments of the last ten years that have shaped also the researchers' key tasks (e.g. with search and retrieval of prior research), the literature reviews have not diversified much from their traditional forms.

This is somewhat surprising given that the manual scan of journals and copying of selected articles in the university library have transformed into an online discovery in various full-text and bibliographic databases. What is more, there are several insightful text mining and information visualization tools that have been developed recently to help the researcher in profiling, mapping and visualizing knowledge domains (Börner et al., 2003; Porter and Cunningham, 2005). Also many bibliographic databases – the well-known ISI Web of Science as the first one – have started to develop embedded tools in their web service to allow the users to analyze search results and easily spot developing and past trends (Thomson, 2006).

The purpose of this paper is to demonstrate by way of an example the potential of text mining, specifically an approach called *research profiling* (Porter et al., 2002) in literature reviews, and to raise discussion about the method's applicability in IS research. The topic of interest in this paper is digital games research, conducted in particular from a business or management school perspective. The motivation for this study stems from the other author's initiating doctoral studies in information systems science on the brand equity (see, for example, Keller and Lehmann, 2006) of digital games. Neither of the authors have previous expertise on digital games research.

This paper is a continuation of a more encompassing study (Bragge and Storgårds, 2007) that examined all digital games research found in the ISI Web of Science (ISI WoS). In that study we profiled more than 2.100 digital game abstracts, and learned that the domain is extremely multidisciplinary, covering more than 170 of the 230 subject categories of ISI. However, computer science and psychology (and their subcategories) alone accounted for half of the research in ISI WoS. We will report here some of the key findings of the previous study, but our main purpose in this paper is to drill down deeper into the data to find out research that is more relevant when studying digital games from a business school perspective.

The remainder of this paper is structured as follows. In Section 2 we describe the research profiling methodology in more detail. Following that, in Section 3 we describe the special characteristics of digital games as information and experience goods. Section 4 demonstrates the profiling of research on digital games. Section 5 is reserved for discussion and conclusions.

Research Profiling

Given that the science abstracts are literally at our fingertips in various electronic R&D databases, Porter et al. (2002) have proposed an approach called research profiling, that is, enhancing the traditional literature review by exploiting modern search engines and sophisticated text mining tools. These tools help elicit useful information from the searches - even if there are thousands of abstracts - to gain perspective on ones' research context. Besides being useful in reporting purposes, the tools allow the researcher to interact with the literature data in unprecedented ways. Thus, they are in a way Decision Support Systems for researchers (Bragge et al., 2007). Porter et al. (2002) recommend that research profiling should become standard practice in every research project, from undergrad papers to large scale research programs.

Table 1 summarizes the key differences between traditional literature reviews and research profiling. The largest difference is based on the amount of literature included, and, consequently, on the type and scope of discussion it allows.

Traditional literature reviews	Research profiling
Micro focus (paper-by-paper)	Macro focus (patterns in the literature as a body)
Narrow range (~20 references)	Wide range (~20 – 20.000 references)
Tightly restricted to the topic	Encompassing the topic + related areas
Text discussion	Text, numerical, and graphical depiction

Table 1. Comparison of traditional literature reviews and research profiling. Source: Porter et al. (2002).

Research profiling is meant to augment – not to replace – traditional literature reviews, by helping in understanding the structure of the subject, important variables, pertinent methods, and key needs. These aims can be better served by analyzing the whole, rather than just a few parts of the research milieu. (Porter et al., 2002). The profiling approach appears to suit particularly well for IS research, as our field is highly multidisciplinary, borrowing theories and frameworks also from other disciplines. Surprisingly often one finds that similar topics than in IS are addressed in several other fields, e.g. in marketing and consumer research. Mostly these instances remain unrecognized, and if not, there simply is no time to dig properly into the neighbor's field. But with research profiling, powered by text mining tools, it is possible to bring breath to the literature review by focusing on the topic, not on disciplinary "sand-boxes".

Webster and Watson (2002) note, as MISQ Review editors, that they frequently receive comments from the reviewers on the limited sample of

journals, focusing on US or a small set of “top” publications. They cited that it is not justified to search by journal instead of searching by *topic* across all relevant journals. Also, selected conference proceedings, especially those with a reputation for quality, should be examined. (Webster and Watson, 2002). Text mining tools enable a much larger set of publications to be scanned routinely.

The conduct of research profiling can be considered as a problem solving process with a structured set of iterative phases. Borrowing from Simon’s (1960) seminal work, Porter and Cunningham (2005) suggest the process to include three main phases: A) Intelligence, B) Analysis & Design, and C) Choice. Each phase includes two to four steps, which are illustrated in Figure 1.

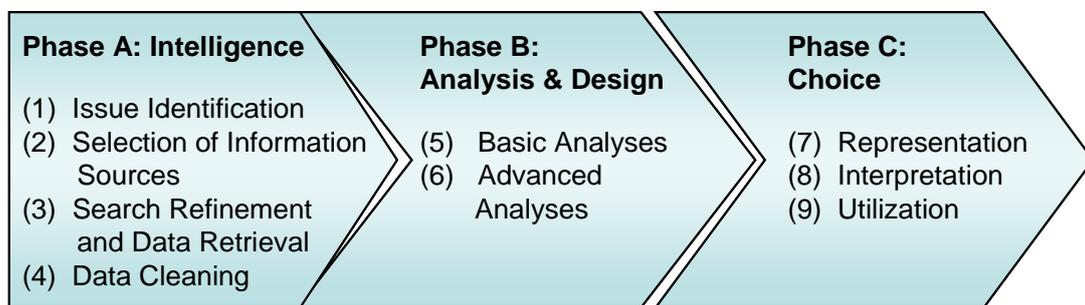


Figure 1: Main phases of the research profiling process. Source: Adapted from Porter and Cunningham (2005).

It should be emphasized that the starting phase is of utmost importance – the time devoted to it corresponds directly to the quality of subsequent phases. Especially the search refinement and the cleaning of the imported data are vital. These tasks may require even several days of work, depending, for example, on previous expertise on the topic, on the size of the sample, or on the data integrity of the database(s) used. The second phase entails conducting both basic analyses based on simple frequency lists, and more advanced analyses utilizing e.g. matrices and multi-dimensional maps. The third phase is about selecting what to report and by which means to illustrate and interpret the key findings in order to answer the main questions of the study (Porter and Cunningham, 2005).

In their article, Porter et al. (2002) demonstrate more than a dozen ways how research profiling may be used to improve literature reviews. These ways – summarized in Table 2 – are divided into three general areas relating to the research context, research community and topics. For more detailed illustrations on each of these, we recommend the article of Porter et al. (2002) to the interested reader.

Depict the *research context* to target research efforts wisely

- observe related topics within the research domain
- observe related topics beyond the research domain
- gain a “big picture” view on the research activity
- at the “big picture” level, find intersecting interests

Understand the *research community*

- identify a range of information sources
- gain insight into how innovation is progressing from literature distribution patterns
- find active organizations and individuals whose research relates to one’s own interests, particularly those working in different disciplines or research domains

Explore *topics (techniques)*

- map (graphically represent) topical interrelationships for a whole research area
- examine how the target topic meshes with other approaches
- generate research opportunities in combining topics, through mapping or in-depth probing
- examine trends to ascertain which topics are hot
- assess the research impact of particular topics
- zoom in to examine promising topics in depth.

Table 2. Using research profiling in improving literature reviews. Source: Adapted from Porter et al. (2002).

In the next section we sketch in brief the landscape of digital games from a business or (marketing) management related perspective. We include this more traditional review here on purpose, as it sets up the specific themes related to the brand equity of digital games we are interested to study in detail. We will concentrate in our profiling study on research that pertains to business or management related issues in later sections.

Digital games as information and experience goods

Digital gaming has a history of 50 years (Bryce and Rutter, 2006). The industry really got started in the late 1970’s when the first interesting game titles like the Asteroids, Space Invaders, Centipede and Pong were launched to the consumer markets (Herman et al., 2002). Digital gaming is now a widely spread phenomenon and at least 70% of the US and Europe households say that they play video or computer games (ESA, 2006; Farrand et al., 2006). Furthermore,

the game industry has grown to be a significant and growing business (Crandall and Sidak, 2006), comparable to the movie industry in financial terms.

Looking from an information economy perspective, digital games are *intangible goods*, although they are often delivered using some sort of tangible support, like a cartridge or DVD (Koppius, 1999). Moreover, in the sphere of intangible goods, digital games represent *information goods* (Shapiro and Varian, 1999). Varian (1998) defines information goods as goods that *can* be digitized (but are not necessarily done so, like newspapers in paper format). However, digital games may be further specified to be *digital information goods*, as they are always in a digital format.

Like information goods in general, also digital games are so-called *experience goods*, because they have to be used first before their value can be determined (Shapiro and Varian, 1999; Nezlek and Hidding, 2001). Nelson (1970) proposed originally the differentiation between the search attributes (e.g. price) and experience attributes (e.g. taste or enjoyment) of goods, the former the consumer is able to determine beforehand and the latter only after purchase or consumption. Darby and Karni (1973) extended this framework with credence attributes, which are qualities a consumer cannot determine even after purchase or consumption (e.g. a medical diagnosis). Zeithaml (1981) has combined these attributes into a value evaluation continuum where the “easy” products possessing many search attributes are on the other end of the continuum, and the more difficult ones, high in credence attributes (often services), are on the other end of the continuum. Products and services high with experience attributes lie in between. This evaluation continuum with representative product and service examples is illustrated in Figure 2, as depicted by Bowman (2004).

Shapiro and Varian (1999) state that most media producers overcome the experience good problem endemic to information goods through branding and reputation. For example, the *Financial Times* “brand” conveys a message to potential readers about the quality of the content, thereby overcoming the experience good problem (Shapiro and Varian, 1999). Also the producers of digital games use various strategies to communicate the quality of their product beforehand, and thus to make the search and evaluation easier for the consumers. Alvisi (2006) lists the common strategies of game producers to include the provision of demonstration versions, the usage of a popular licences, massive marketing campaigns, and the usage of franchises and mascots. He also states that the use of mascots is no different from the use of other forms of branding.

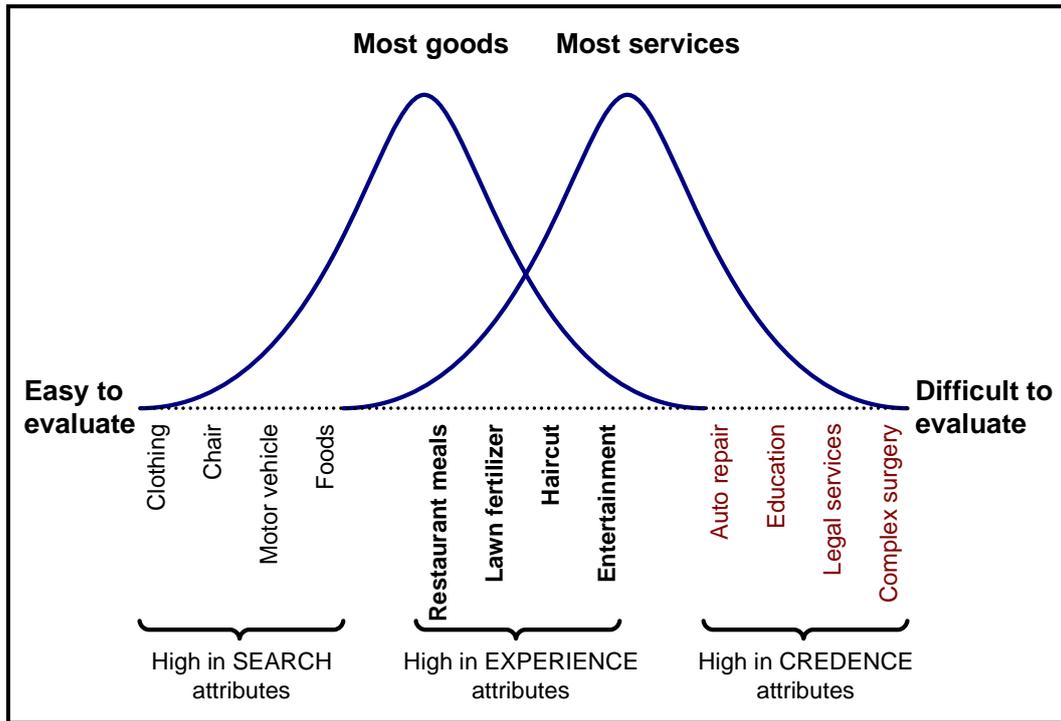


Figure 2: Zeithaml's evaluation continuum based on the search, experience and credence attributes of goods and services. Source: Adapted from Bowman (2004)

Klein et al. (1998) have presented that technology now makes it possible for experience to occur prior to purchase, through what they label “virtual experience”. Thus, through the provision of various experimental information (e.g. reviews on websites, virtual word-of-mouth), the formerly classified experience goods can become search goods in the sense that consumers are able to obtain critical product information prior to purchase (Klein, 1998). This may – to some extent – diminish the importance of brands as a conveyor of product quality in some consumers' choice processes (see discussion also in Ahonen and Moore (2005)). Nevertheless, brands and branding continue to be an extremely important managerial area for game producers.

Profiling research on digital games

In this section we first give a general overview of digital games research that is indexed at the ISI Web of Science (Science-Expanded, Social Science or in Arts & Humanities Citation Indexes). Secondly, we drill down to research on digital games that is related to business or management.

Overview of digital game research

Bryce and Rutter (2006) studied briefly in their introductory chapter to *Understanding Digital Games* how the amount of ISI journal publications have developed on computer game(s) and on video game(s). They found 275 articles in years 1995-1999 and 535 articles in years 2000-2004, and concluded that the amount of research has almost doubled in the latter 5-year period. To peruse the phenomenon more closely, we conducted a full-scale profiling study on digital games research indexed by the ISI Web of Science (Bragge and Storgårds, 2007). Our search phrase included more than a dozen other stem words than computer or video game/s (e.g. online game/s, mobile game/s, virtual game/s), in order to get as wide a sample of digital games research as possible. The search was conducted in February 2007, and it resulted in 2.136 records from the past 20 years (ISI WoS coverage begins only from 1986). A more detailed account on this initial Intelligence phase of our research profiling (i.e., database selection, search refinement and data cleaning) can be found in Bragge and Storgårds (2007).

Research profiling should answer to questions such as “Who?”, “What?” and “When?” (Porter and Cunningham, 2005; Porter et al., 2002). We aimed at finding answers to such questions as what are the main areas of science which study digital games, who are the prolific authors, which institutions conduct digital game studies, what scientific areas and disciplines they represent, what are the “hot” topics or trends in digital game research, when has digital game research been conducted and how has it changed over time. In the following paragraphs, we will answer to these issues adhering to the profiling phases of Analysis & Design, and Choice (see Section 2 and Figure 1 earlier).

The sample contained research from a respectable amount of disciplines, classified into more than 170 out of some 230 different ISI subject categories. One article may belong to several subject categories. In Table 3 we have listed the largest single disciplinary categories of the sample. Studying only these top-10 categories represent 48% (1.017) of the records of the sample (the total sum in the table is larger than 1.017 as one article may belong to several categories). Computer Science and Psychology dominate the list. Note that IS research is oftentimes categorized under “Computer Science, Information Systems” at ISI

WoS, as it has no such categories as “Information Systems” or “Information Systems Science”.

Subject category	#	%
Computer Science, Theory & Methods	268	22 %
Computer Science, Software Engineering	154	12 %
Psychology, Multidisciplinary	141	11 %
Psychology, Experimental	125	10 %
Communication	99	8 %
Psychology	98	8 %
Computer Science, Artificial Intelligence	92	7 %
Psychiatry	90	7 %
Engineering, Electrical & Electronic	88	7 %
Computer Science, Information Systems	83	7 %
	1.238	100 %

Table 3. Top-10 ISI subject categories.

Due to the wide spread, we wanted to group the research into larger wholes. With the advice from Moya-Anegón et al. (2004) we found one classification that groups ISI categories in superior classes. After the grouping, three major areas of science conducting digital game studies emerged. These areas are the Social Sciences, Law and Economics (30%), Health Sciences (29%) and ICT and Mathematics (25%). Also Arts and Humanities (6%) as well as Engineering (6%) were prominent. The rest (4%) were classified under “Others”. As digital game research spans also over these major areas of science (one record may be classified in two or three areas), we wanted to see how much there is overlap in the sample. A Venn-diagram helped to get a snapshot view of this (see Figure 3).

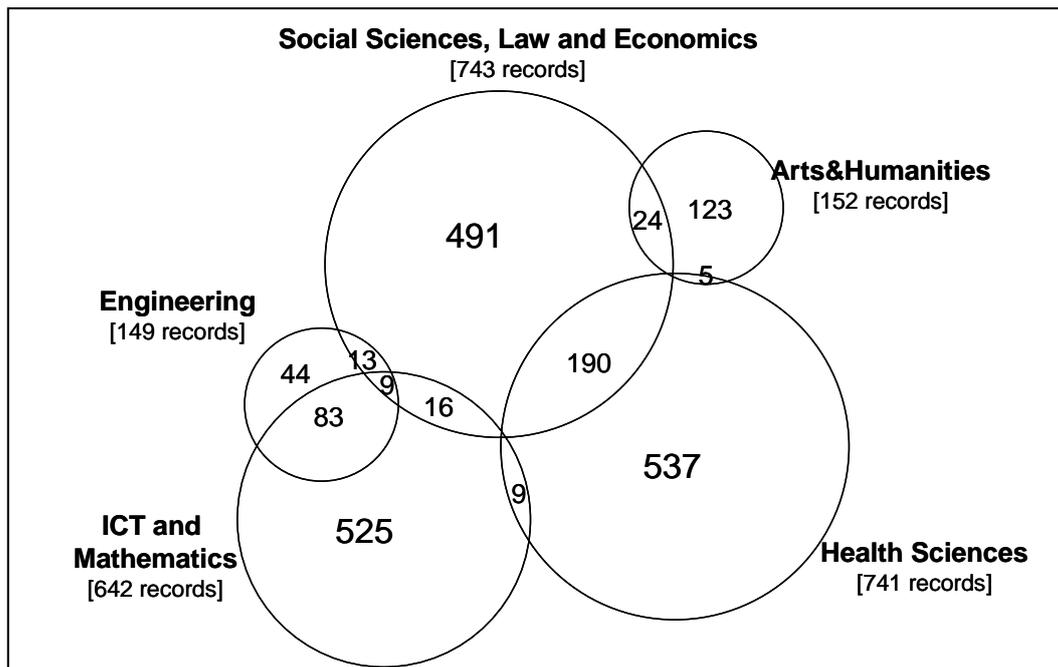


Figure 3: Venn-diagram on main areas of science conducting digital game research.

Due to the multidisciplinary nature of digital games research, we think it is justifiable to study the prolific authors, key journals, main keywords etc. separately inside each major area rather than from the whole sample. Consequently, we studied the sample in groups. Table 4 profiles the sample separately under the Social Sciences, the Health Sciences, and ICT & Math and Engineering. Engineering was combined to ICT due to the large overlap of these areas (see the Venn-diagram above). The profiles – covering key disciplines, countries, affiliations, authors, journals, authors' keywords, and keywords plus – that are presented in Table 4, are based on 91% of the sample's records. The Keywords Plus are terms, which ISI derives from the titles of cited papers, and processes these algorithmically to identify the most-commonly recurring words and phrases (Thomson, 1994).

One way of characterizing the digital games research community is by studying how many times each article has been cited (see Figure 4). In this sample, 7 % (152) of the publications have 20 or more citations (of which 9 articles have more than 100 citations). In contrast, 76 % (1.631 publications) of the sample have less than 5 citations. More than half (52 %) of the publications have been never cited. It is difficult to say what is a typical citation structure of a domain, but it appears as though these figures are lower than normally. This might be due to the exceptionally large multidisciplinary nature of the domain. On average, each publication is citing 23 references.

	Social Sciences, Law and Economics [743]	Health Sciences [741]	ICT, Mathematics and Engineering [699]
Key disciplines	Psychol., Multidisc. [141] Communication [99] Psychology [98] Psychol., Experim'l [79] Psychol., Develop'l [72]	Psychol., Experim'l [125] Psychiatry [90] Psychology [82] Pediatrics [81] Clinical Neurology [80]	Comp Sci, Theory & Methods [268] Comp Sci, SE [154] Comp Sci, AI [92] Engineering, Electrical & Electronic [88] Comp Sci, IS [83]
Key countries	USA [256] UK [76] Canada [33] Germany [26] Australia [24]	USA [285] UK [64] Canada [43] Australia [29] France [23]	USA [169] UK [73] South Korea [59] Germany [43] China [35]
Key affiliations	Univ Texas [15] Nottingham Trent U [14] Iowa State Univ [12] Med Coll Georgia [9] Univ Illinois [9] Univ Missouri [9]	Med Coll Georgia [24] Harvard Univ [22] Univ N Carolina [15] Univ Pittsburgh [15] Stanford Univ [10]	MIT [11] Univ Alberta [10] Univ Maastricht [10] Georgia Inst Technol [9] Kyungpook Natl U. [9] Univ Texas [9]
Key authors	Griffiths, M D [18] Anderson, C A [14] Funk, J B [9] Treiber, F A [9] Davis, H [8]	Treiber, F A [22] Davis, H [18] Strong, W B [10] Miller, S B [9] Harshfield, G A [8] Kapuku, G K [8] Trenite, DGAKN [8]	Mauve, M [6] Moltenbrey, K [6] Nussbaum, M [6] Paiva, A [6] Schaeffer, J [6]
Key journals	CyberPsychol. Beh. [32] Forbes [26] Psychophysiology [23] Psychosom. Med [21] J. Adolesc [15]	Epilepsia [24] Psychophysiology [23] Psychosom. Med [21] Percept. Mot. Skills [20] Pediatrics [19]	Electron. Libr [21] Comp. Graph. World [16] Commun. ACM [13] Computer [13] Comput. Graph.-UK [10] IBM Syst. J [10]
Top keywords (authors') (search words not included)	Aggression [18] Adolescents [17] Stress [15] Sex-differences [14] Exposure [13]	Adolescents [38] Television [37] Children [36] Blood pressure [34] Stress [29]	Internet [9] Virtual environment [8] Animating [7] Virtual reality [7] Education [6] Hum-comp interact. [6] User interface [6]
Top keywords (Plus) (search words not included)	Children [70] Behavior [68] Adolescents [44] Performance [30] Aggression [26] Personality [26] Responses/reactivity [26]	Children [85] Adolescents [56] Responses/reactivity [47] Physical-activity [36] Behavior [34] Obesity [34]	Model [16] System [9] Performance [8] Internet [7] Behavior [5] Design [5]

Table 4: Profiles of main scientific areas conducting digital games research.

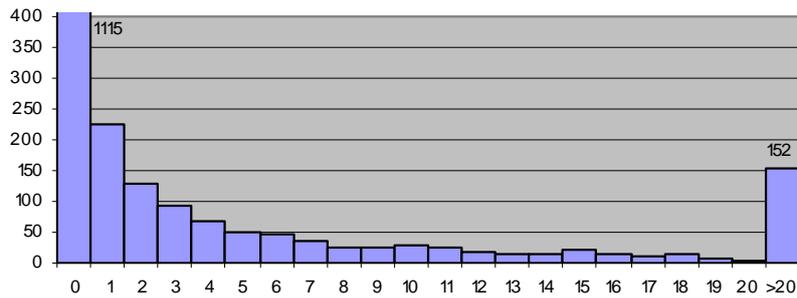


Figure 4: Publications presented by how many times they have been cited.

In order to find out the trends over time in research we grouped the sample in 5-year periods. First, we study how the main areas of science have developed since 1987 in 5-year periods. In order to make the statistics more comparable, we have excluded 258 conference articles in the next figure and table, as we found that ICT & Mathematics was practically the only area in ISI WoS that contained conference proceedings (mostly Springer’s Lecture Notes e.g. in Computer Science). We are not aware what the factors are behind this disparity. From Figure 5 it appears that ICT & Math has grown at a larger pace than any other area.

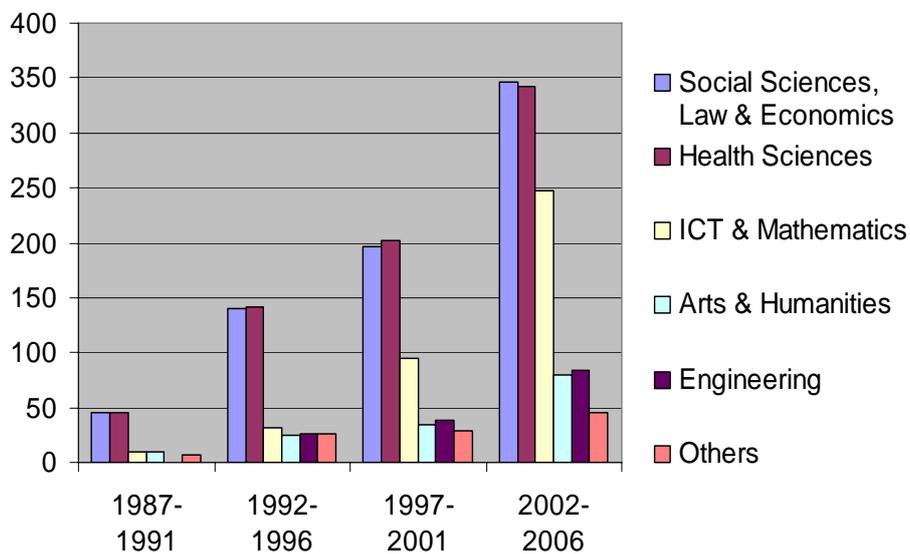


Figure 5: Trends in research publications by areas of science (only journal articles)

We calculated the growth percentages between the last two 5-year periods of each area. The numbers in Table 5 confirm that ICT & Math has indeed grown fastest, with 160 %. The second fastest growing area is Arts & Humanities, with 129 %.

Area of science	Growth
ICT & Mathematics	160 %
Arts & Humanities	129 %
Engineering	115 %
Social Sciences, Law & Economics	77 %
Health Sciences	69 %
Others	55 %

Table 5: Growth of main areas of science between two 5-year periods of 1997-2001 and 2002-2006.

Next, we studied the trends in authors' keywords. It can be seen from Table 6 that the issues related to 1) adolescents and children, 2) media (television, computers and the internet) and 3) health have been important throughout the last 15 years of digital game research (the years before 1992 are not included in the table as the ISI WoS sample reports only few keywords before that time). The health related keywords, i.e. heart rate, cardiovascular reactivity, stress and blood pressure, have relatively diminished in importance, and given up space for other ones, like the Internet. This is an indicator of a shift in the research focus.

Besides author-defined keywords, it is possible to study also the titles of the research papers utilizing Natural Language Processing (NLP) to parse words and noun phrases from the titles. We conducted a title analysis separately in each area of science, and in two "time slices" in the last 10 years. The results regarding the ICT and Mathematics area are presented in Table 7. Such topics as mobile games, interactive computer/video games and multiplayer online games have clearly entered the researchers' agenda in the last five years.

Keywords (authors')	1992-1996	1997-2001	2002-2006	Whole sample
Video games	11	25	73	110
Computer games	8	24	50	84
Adolescents	2	15	29	47
Children	6	18	17	44
Television	1	15	26	43
Blood pressure	14	8	9	34
Internet	1	8	21	30
Stress	11	7	9	29
Computer	1	4	22	27
Game	0	4	19	24
Cardiovascular reactivity	13	5	3	23
Physical activity	2	7	14	23
Virtual reality	1	8	13	22
Aggression	1	6	13	20
Heart rate	10	1	6	20

Table 6: Trends in top-15 keywords (authors') of the whole sample (presented in descending order by the last column)

ICT & Mathematics

1997-2001 [107]

Computer games [8]
 Online / Internet games [5]
 Game [4]
 Video games [4]
 Development [2]
 Distributed interactive media [2]
 Engagement [2]
 Multiplayer games [2]
 New approach [2]
 Sound [2]
 Video / Computer game playing [2]
 Virtual environment [2]

2002-2006 [482]

Computer games [33]
 Online / Internet games [18]
 Game [16]
 Video games [11]
 Mobile games [10]
 Application [8]
 Interactive computer / video games [7]
 Virtual environment [7]
 Effects / impact /influence [6]
 Multiplayer games [6]
 Multiplayer online games [6]

Table 7: Prolific title words in ICT & Math in 1997-2001 and 2002-2006, processed using NLP.

To close up the illustration of digital games research profiling in general, we present in Figure 6 the trends of key indicators (i.e., number of publications, subject categories, authors, affiliations, countries, journals, outlets - including conference proceedings, and keywords plus). For example, the trend Authors shows how many *different* authors, on average, have published digital game research in each 5-year period. The trends tell us that the research in digital games is clearly expanding in every respect. When comparing these trend results with a recent profiling study on Group Support Systems conducted by Bragge et al. (2007), we found that contrary to common beliefs, an ever-increasing trend regarding technology-related studies is not always the case. Although the Internet has revolutionized the landscape regarding computer-based Group Support Systems too, it was not yet reflected in the 25-year history of GSS research in the same way as regarding digital games research.

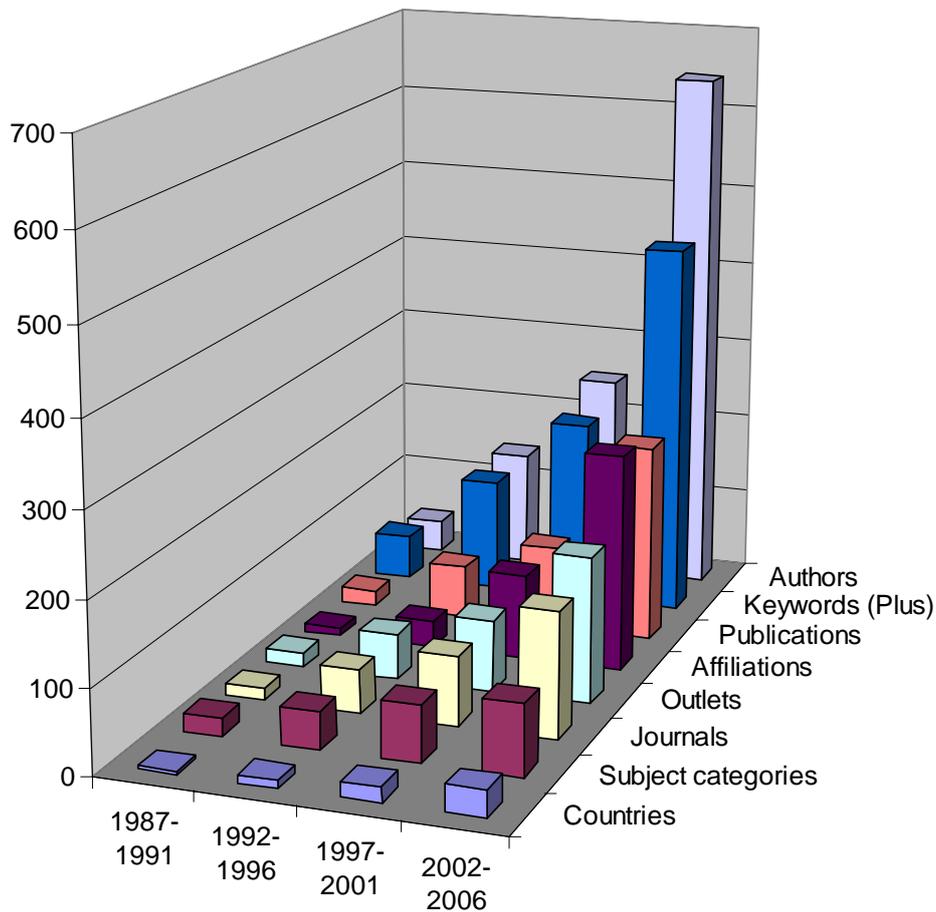


Figure 6: Trends of key indicators (the bars depict the yearly statistics averaged over a 5-year period)

Business and management related digital game research

We continue our profiling study by drilling down deeper into the sample’s data, using a business or management lens. The word business can be defined as “*the activity of providing goods and services involving financial and commercial and industrial aspects*”. Management, on the other hand, is “*the act of managing something*” or it refers to “*those in charge of running a business*” (WordNet).

Concurrently, we also demonstrate the interactive search potential of text mining tools in supporting the researcher. The tool we have used here is Search Technology’s VantagePoint, which has been developed in collaboration with the Georgia Institute of Technology. As mentioned in the introduction, similar types of analysis tools are embedded also in some science databases. However, their capabilities are still much more limited than in a full-scale tool.

We first selected the research on those subject categories that were deemed relevant for our detailed examination. This was conducted by forming a new grouping, named *BusMgmtEcon*, under the subject category sheet, and selecting appropriate categories to it. The categories selected were Business [37], Business: Finance [31], Management [24] and Economics [14]. The number of records of this selection totals to 91 (the straight sum would be 106, but there are overlaps, i.e. records that are classified under two or more of the above categories). Figure 7 illustrates this by means of a screenshot from the VantagePoint (VP) software.

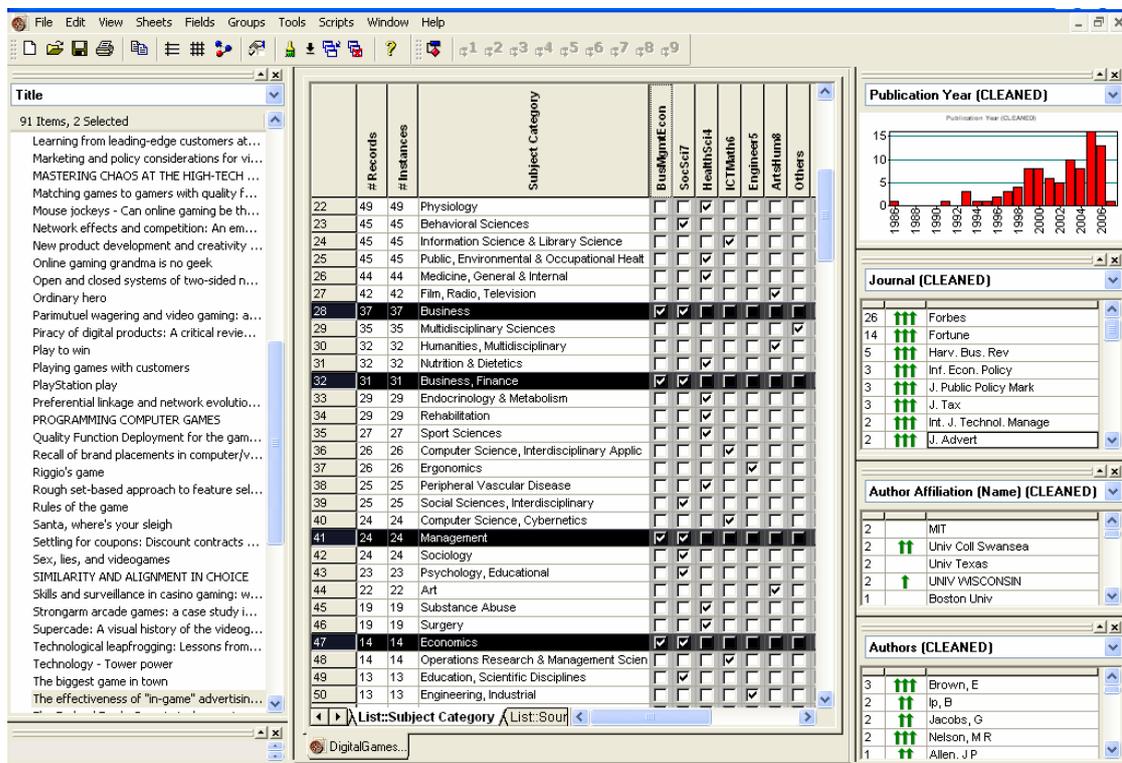


Figure 7: Screenshot from VP illustrating the ” interactive search” of the researcher.

When selecting the *BusMgmtEcon* group by activating it (from the proper column heading), one can immediately see some aggregated details of the selection in the right-hand of the screen. The user may choose how many detail windows to show, and what fields are displayed in them. In Figure 7 the detail windows include Publication year, Journal, Author Affiliation, and Author. The user can continue the interactive examination in this screen by selecting any row (or publication year bar) from the detail windows. In this example the user has selected the Journal of Advertising from the journal list. This activation immediately marks in gray from the left-hand column those articles that are published in that specific journal. The user may then double-click any grayed title in order to peruse the whole records as imported from the ISI WoS database.

Regarding business and management related digital games research, one finds that there is not much of it. The journals that are on the top (Forbes, Fortune) are not publishing the type of academic articles we were looking for, although as business managers' readings they are relevant also to researchers as supplementary material. We could have eliminated much of the managerial journal material from the sub-sample by deselecting "Business, Finance" (all 26 Forbes articles would have been removed, and 4 others that were not that relevant either). However, the category Business includes 23 articles, besides those 14 that are published in Fortune, which are highly relevant to our detailed search. Thus, we changed the strategy and formed a new *BusMgmtEcon* grouping, this time under the Journals sheet. We searched through all journal titles that included the word *bus**, *manage**, *econ**, *adv**, *mark**, *cons**, *comm** or *inf** and marked those that consisted of relevant articles when checked concurrently using the detailed record displays. We did yet additional checks, for example, to ensure that all relevant journals from the previous category-based sub-sample were included. This led to 51 records (published in 26 journals). All in all, it is a very modest amount.

The *BusMgmtEcon* sample's journals that have published two or more digital games related articles are presented in Table 8.

Journal	#
Communication of the ACM	13
Harvard Business Review	5
Information Economics and Policy	3
Journal of Public Policy Marketing	3
Information Society	2
International Journal of Technology Management	2
Journal of Advertising	2
Journal of Computer Information Systems	2
Total Quality Management & Business Excellence	2

Table 8: List of top-9 journals of *BusMgmtEcon* sample.

The subject categories of the sub-sample are presented in Table 9. It appears that the subject categories are defined by ISI at the journal level, and not on the level of an individual article, as one would assume. This conclusion can be made by studying the 13 articles from the Communications of the ACM – all of them have the same three subject categories: Computer Science (CS): hardware & architecture, CS: software engineering, and CS: theory & methods. As CACM publishes also IS research, it is not advisable to rely on the subject categories only in similar analyses.

Subject category	#
Business	19
Management	18
Computer Science, Hardware & Architecture	13
Computer Science, Software Engineering	13
Computer Science, Theory & Methods	13
Economics	6
Computer Science, Information Systems	5
Communication	4
Information Science & Library Science	4

Table 9: Top-9 subject categories of *BusMgmtEcon* sample

The keywords (plus) are presented in Table 10. They are related among others to information economics (externalities, network externalities) and to marketing topics (advertisements, consumers, product).

Keywords (Plus)	#
Externalities	4
Information	4
Firm	3
Advertisements	2
Compatibility	2
Competition	2
Consumers	2
Industry	2
Information technology	2
Network externalities	2
Organization	2
Performance	2
Product	2
Strategies	2
Usage	2

Table 10: Top-15 Keywords (Plus) of *BusMgmtEcon* sample

To conclude, we illustrate yet one powerful interactive feature of the text-mining tools. The terms (e.g. authors, keywords) can be studied on a multi-dimensional scaling map based either on auto-correlation, cross-correlation or on factors of the terms.

The auto-correlation map in Figure 8 represents the relationships between most common words and multi-word phrases used in abstracts. Due to the small size of the *BusMgmtEcon* sample, we picked up a few other interesting words besides the most common ones to the analysis to better illustrate its capabilities. The node size in the map reflects the item's relative frequency in all 51 abstract records. The placement is based on a multi-dimensional scaling routine. Topics depicted close together are more apt to be associated based on the extent of co-occurrence in particular abstract records. Connecting lines indicate relative degree of association (the absence of a link means *less* association, not no association). Lines are generally better indicators of linkage than closeness. (Porter et al., 2002).

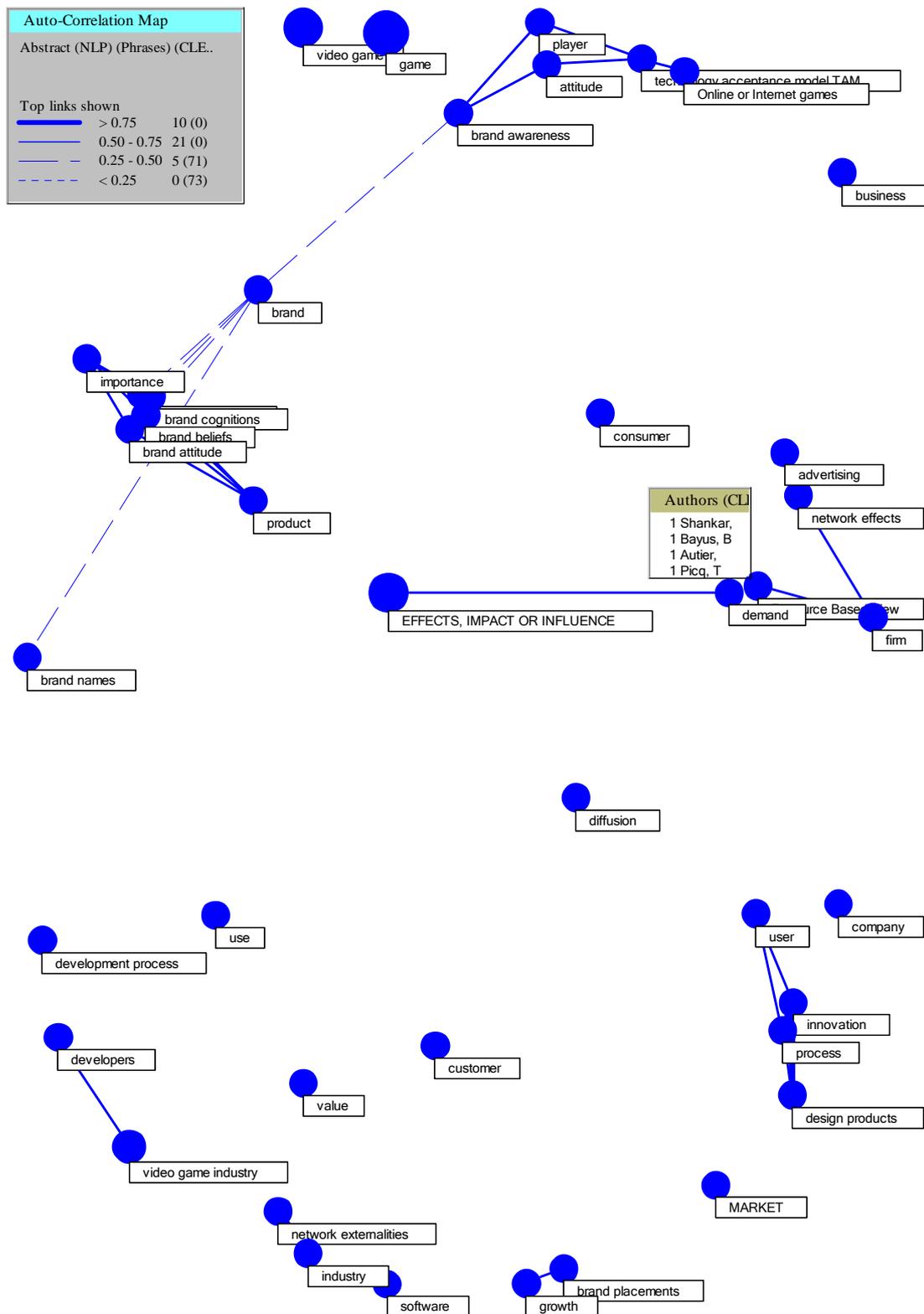


Figure 8: Auto-correlation map of selected words and phrases used in the abstracts of the *BusMgmtEcon* sample.

The map can be used as a tool to find out what terms appear together in the same context. The nodes and their placements with connecting lines thus give an overall indication which issues and also methods are discussed in same studies. In Figure 8 we may locate a few groupings. The first group includes actually two subgroups that are connected by two terms (brand, brand awareness). There exists a relationship with terms such as player, attitude, technology acceptance model TAM, online or internet games and brand awareness, which are connected with the subgroup of other brand-related issues (brand attitude, brand beliefs, product and importance). One could assume that in cases of studying the first subgroup there is also a connection to the second subgroup and the other way round. Another group of nodes is about demand, Resource Based View, firm and network effects. Yet, one group considers issues such as user, innovation, process, and design products.

The researcher is able to examine these connections in more detail, since the map works as an interactive search platform: when clicking one node, the contents of the detail windows change concurrently. Only one detail window, *Authors*, is shown in the map of Figure 8. The other detail windows (not shown) are located in the right-hand column of the screen similarly to Figure 7 presented earlier. As the sample in this illustrative example is relatively small (51 studies) and also heterogeneous, the reader should be cautious not to generalize these results. The strength of this type of analysis becomes better visible when more abstracts are studied at a time. But we hope this example was able to convey the support that this type of multidimensional and interactive tool is able to provide for the researcher when studying the literature.

Discussion and conclusions

The aim of this paper was to introduce a relatively unknown literature review method - *research profiling* - to IS researchers. Besides giving an overview of the method, based on Porter et al. (2002) and Porter and Cunningham (2005), we also demonstrated the method's use by profiling the literature found from the ISI Web of Science on digital games. We used sophisticated text mining tools to conduct the analysis. The results of our study showed that although there is an abundance of research on digital games in general, the majority of it is done from the perspectives of computer science or psychology. Only some 50 articles had a business, management or economics related viewpoint. This points out to an obvious gap in the literature, given the increasing significance of digital game-playing in the economy (see discussion e.g. in Hagel, 2007; Prensky, 2003).

In future research, other science databases should be studied to find out whether more academic research on digital games especially from a business school perspective may be found. Potential databases are INSPEC, ABI/Inform ProQuest and Business Source Premier/EBSCO. As the ISI WoS is the "gold

standard” by which some governments (e.g. in USA, UK, Australia) evaluate their national R&D performance (Porter and Cunningham, 2005), we wanted to start our profiling study with that database. Moreover, ISI WoS offers a dense coverage of most areas of science, and it is cleanly and uniformly structured (Porter and Cunningham, 2005).

We have produced an initial search on INSPEC, and found more than 5.000 records using the same search words as in this study. INSPEC is provided by the the Institution of Engineering and Technology, covering broadly such fields as physics, telecommunications, computer science and information technology (IET, 2007). The applied and industrial focus of INSPEC makes it an attractive source especially for technology studies (Porter and Cunningham, 2005), but also for business practitioners and researchers (Chung et al., 2003). INSPEC’s coverage on conference articles is much larger than that of ISI’s, which brings also more up-to-date research on the analysis. Although INSPEC is an “engineering” database, it appears that some 400-500 digital games studies are classified under business, management or economics categories in our preliminary study. However, the cleaning of this data is still in progress and we will report on more detailed findings in later studies.

We hope that IS researchers find the research profiling method interesting, and we expect to see more studies done with it in the future. Basic trends and statistics may be conducted even using the science databases’ embedded analysis tools (see more details, e.g., in Thomson, 2006). Furthermore, similar text mining tools that was used in this study can help IS researchers to analyze also empirical data, such as interview data, free-form feedback from surveys, or blogs. For instance Airo et al. (2002) discuss the potential of text mining tools and represent several ways how to utilize them in research.

References

- Ahonen, T.A., and Moore, A. (2005). *Communities Dominate Brands. Business and Marketing Challenges for the 21st Century*, Futuretext, London, UK, 274.
- Airo, K., Jouhtio, M., Keskinen, V., and Lehtinen, T. (2002). "The Market Potential of Text Mining in Finland", Helsinki University of Technology, 39.
- Alvisi, A. (2006). "The Economics of Digital Games", in: *Understanding Digital Games*, J. Rutter and J. Bryce (eds.), Sage Publications, London. 272.
- Bowman, D. (2004). "Experience Effects on Brand Choice", Zyman Institute of Brand Science, Available at <http://www.zibs.com/bowman1.shtml>, Last accessed on April 3, 2007.
- Bragge, J., Relander, S., Sunikka, A., and Mannonen, P. (2007). "Enriching Literature Reviews with Computer-Assisted Research Mining. Case: Profiling Group Support Systems Research", *Proceedings of the CD-Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS)*, January 3-6, Big Island, Hawaii.
- Bragge, J., and Storgårds, J. (2007). "Profiling Academic Research on Digital Games Using Text Mining Tools", *Proceedings of the Digital Games Research Association's DiGRA 2007 conference (to appear)*, September 24-28, Tokyo, Japan, DiGRA, 1-16.
- Bryce, J., and Rutter, J. (2006). "An Introduction to Understanding Digital Games", in: *Understanding Digital Games*, J. Rutter and J. Bryce (eds.), Sage Publications Ltd, London. 272.
- Börner, K., Chen, C., and Boyack, K.W. (2003). "Visualizing Knowledge Domains", in: *Annual Review of Information Science & Technology*, B. Cronin (ed.), Information Today Inc./ASIST, Medford, NJ. 179-255.
- Chung, W., Chen, H., and Nunamaker, J.F. (2003). "Business Intelligence Explorer: A Knowledge Map Framework for Discovering BI on the Web", *Proceedings of the Hawaii International Conference on System Sciences*, Big Island, Hawaii, IEEE, 1-10.
- Crandall, R.W., and Sidak, G.J. (2006). *Video Games, Serious Business for America's Economy.*, Entertainment Software Association.
- Darby, M.R., and Karni, E. (1973). "Free Competition and the Optimal Amount of Fraud", *Journal of Law and Economics*, vol. 16, no., 67-88.
- ESA (2006). *Essential Facts About the Computer and Video Games Industry 2004-2006*, Entertainment Software Association.
- Farrand, T., Nichols, D., Rowley, T., and Avery, M. (2006). *Brands & Gaming*, Palgrave MacMillan, New York.
- Hagel, J. (2007). "Gaming and Learning", Edge Perspectives, January 1, Available at http://edgeperspectives.typepad.com/edge_perspectives/2007/01/gaming_and_lear.html, Last accessed on April 3, 2007.
- Herman, L., Horwitz, J., Kent, S., and Skyler, M. (2002). "The History of Video Games", Gamespot, Available at <http://www.gamespot.com/gamespot/features/video/hov/>, Last accessed on April 3, 2007.
- IET (2007). "Inspec", IET, Available at <http://www.iee.org/publish/inspec/>, Last accessed on April 3, 2007.
- Keller, K.L., and Lehmann, D.R. (2006). "Brands and Branding: Research Findings and Priorities", *Marketing Science*, vol. 25, no. 6, 740-759.
- Klein, L.R. (1998). "Evaluating the Potential of Interactive Media through a New Lens: Search Versus Experience Goods", *Journal of Business Research*, vol. 41, no., 195-203.
- Koppius, O. (1999). "Dimensions of Intangible Goods", *Proceedings of the 32nd Hawaii International Conference on Systems Sciences*, January, Hawaii, USA.

- Moya-Anegón, F., Vargas-Quesada, B., Herrero-Solana, V., Chinchilla-Rodríguez, Z., Corera-Álvarez, E., and Muñoz-Fernández, F.J. (2004). "A new technique for building maps of large scientific domains based on the cociation of classes and categories." *Scientometrics*, vol. 61, no. 1, 129-145.
- Nelson, P. (1970). "Information and Consumer Behavior", *Journal of Political Economy*, vol. 78, no. March/April, 311-329.
- Nezlek, G., and Hidding, G. (2001). "An Investigation into Differences in the Business Practice of Information Industries", *Human Systems Management*, vol. 20, no. 2, 71-81.
- Porter, A.L., and Cunningham, S.W. (2005). *Tech Mining. Exploiting New Technologies for Competitive Advantage*, John Wiley & Sons, Inc., Hoboken, New Jersey.
- Porter, A.L., Kongthon, A., and Lu, J.-C. (2002). "Research Profiling: Improving the Literature Review", *Scientometrics*, vol. 53, no. 3, 351-370.
- Prensky, M. (2003). "Digital Game-Based Learning", *Computers in Entertainment*, vol. 1, no. 1, 1-4.
- Shapiro, C., and Varian, H.R. (1999). *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press, Boston, Massachusetts, 351.
- Simon, H.A. (1960). *The New Science of Management Decision*, Harper and Row, New York, NY.
- Thomson (1994). "The Concept of Citation Indexing: A Unique and Innovative Tool for Navigating the Research Literature", Available at <http://scientific.thomson.com/free/essays/citationindexing/concept/>, Last accessed on April 3, 2007.
- Thomson (2006). "ISI Web of Knowledge Analyze Tool Allows Users to Spot Trends, Trace the History of Scientific Thought", *Thomson.com*, Available at <http://www.scientific.thomson.com/press/2006/8304961/>, Last accessed on March 18, 2007.
- Varian, H.R. (1998). "Markets for Information Goods", Manuscript, University of California, Berkeley, Available at <http://www.ischool.berkeley.edu/~hal/Papers/japan/>, Last accessed on April 2, 2007.
- Webster, J., and Watson, R.T. (2002). "Analyzing the Past to Prepare for the Future: Writing a Literature Review", *MIS Quarterly*, vol. 26, no. 2, xiii-xxiii.
- Zeithaml, V.A. (1981). "How consumer evaluation processes differ between goods and services", in: *Marketing of Services*, J.H. Donnelly and W.R. George (eds.), American Marketing Association, Chicago, Illinois. 196-199.

Viable Intranets for Viable Organizations – The Shared and Common Intranet

Christina Amcoff Nyström

Department of Information Technology and Media

christina.amcoff@miun.se

Abstract. The potentiality of the intranet concept, enabled by the empowerment of employees, is to a high degree missing in examples of successful implementation. Intranet implementation is not an end in itself. The purpose of this technology is to support an organisation. In order to make the organization viable, the intranet should be designed to support and facilitate interaction when sharing knowledge and communication throughout the organisation. This paper presents ideas to be considered when planning and designing an intranet in an organisation. These ideas are primarily based on the concept of empowerment and common making owing to the technology in use. First, making the view of the technology common can be carried out through the active use of Philosophy of Technology, here represented by the CUT-P model which shows the connections between conceptions, use, technology and policy. Second, ideas have been inspired by the Viable System Model. Corresponding functions in an intranet are presented in VSM terminology. Contributions can be divided into four paragraphs: Recommended functions based on VSM are suggested. Recommendations owing to completion of the policy with ideas how to work with the CUT-P model representing the Philosophy of Technology are presented. Furthermore, fundamentals for 1) an implementation model according to functions and the corresponding changes in the organization, is recommended as well as 2) an interface model with the aim to develop the interface so the underlying technology is visible and the ideas of the VSM is “visible” in the interface.

Keywords. Intranet, viable system model, empowerment, Philosophy of Technology, participation

Introduction

Despite the potential of Intranets for spreading and sharing information, communication and knowledge management, there are also a lot of failures concerning design, implementation, development and acceptance (Banck and Nyström, 2005; Swan et al, 1999). There is also an exaggerated focus on technology rather than on social context (Kling 1999, 2000) and discouraging findings pertaining to Intranets intended to support knowledge management (Damsgaard and Scheepers, 2001). In short, there are a lot of problems or missed opportunities. This, despite the potential in forms of Intranet as a collaborative tool. Furthermore, Intranet has an ability to support the organization according to communication, information sharing, coverage of trends threats and signals from customers and the market in the world around.

An Intranet is a concern for everyone in an organization. The potential and limitations of the technology such as suitable functions – working tools – and knowledge about what the Intranet does and does not offer, must be known. An Intranet offers a Net – a common architecture or skeleton. An Intranet's ability to support communication and information exchange can be further improved by a cybernetic view. Stafford Beer is the founder of organizational cybernetics and has redefined traditional cybernetics as the “science of effective organization” (Jackson, 2003). The combination of Beer's cybernetic model – the Viable System Model – and Intranet development is a challenge and would be of great interest due to the development of viable organizations. The VSM is chosen because it offers a scientific justification for empowerment and democracy in organizations. In essence, the VSM is about the design of organizations as adaptive/goal-seeking entities and pinpoints various systemic/structural laws that must be observed if an organization is to be viable and succeed (Jackson, 2003). Furthermore, the policy should be anchored and common in the organization. Accordingly, the Philosophy of Technology must be analyzed and discussed in order to understand and learn about the technology in use as well as potential – and limitations - of technology in general. A high degree of empowerment as well as real opportunities to influence and participate in the different development processes are essential issues. These issues demand an Intranet designed as a concern for all employees, where support of autonomous sub-parts are essential, functions including feedback and feed-forward between operational sub-systems and control functions must be implemented. Furthermore, the interface between the environment and the system as well as between parts in the system, should have functions for attenuating and amplifying information according to the desires of the receiver.

The purpose with this paper is to present the results of combining the Viable System Model with Intranet technology. The combination has resulted in a design of functions recommended for implementation in an Intranet in order to support

the organization as a viable system. Recommendations for how to implement and make the Philosophy of Technology common in organizations are also given. Furthermore, implications for further research, regarding visualising the technology through the interface and fundamentals for an implementation model, is presented.

A need for change....

As mentioned above, despite the promise of Intranet as a possible skeleton and its ability to make people “network” and share the same view through a common interface, there is a need for a change due to unused potentiality in Intranets. This potentiality is partly identified (Banck and Nyström, 2005), further developed (Nyström, 2006a; 2006c) and designed (Nyström 2006b) in terms of functions and ways to work with the policy of organizations. This change is visualized in Figure 1 below.

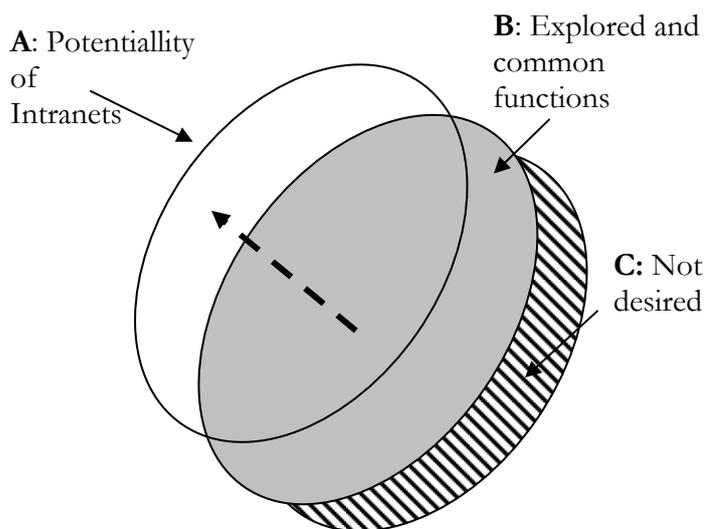


Figure 1. Intranet of today is represented by the grey area - B. C represents potentially undesired functions or possibilities, A is potentiality not used but which should be developed.

The figure above raises the following questions:

- What is needed to move the Intranet from B to A? E.g. increase the number of functions such as functions for analyzing the environment through intelligent agents.
- What is needed to eliminate C (If C exists)? E.g. outdated functions.
- What does A mean in terms of

- Functionality?
- Content?
- Participation?
- Empowerment?

The move from B to A demands some kind of implementation model (see Section 6). The second question (elimination of C) is academic because it needs concrete examples. The third question pertaining to functionality and content is exemplified by findings from the combination of VSM and Intranet (see Section 6), Participation and Empowerment are both connected to findings from the combination of VSM and Intranet as well as findings from the development of the CUT-P model influenced by the Philosophy of Technology – see Section 6 below.

Viable Organizations

In order to make an organization viable there are some critical conditions that must be considered since they influence the Viable Organization in some way. Each identified condition is referenced to different findings and the sum and combination of these conditions is one of the contributions of this paper. The conditions are presented in the following open-ended list:

- empowerment of employees (Stenmark, 2002; Beer, 1972, 1974, 1979, 1985; Duane and Finnegan, 2003; Banck and Nyström, 2005; Nyström, 2006a; 2006c; Kelly, 1998)
- democracy in the potential to influence in the different processes (Beer, 1972, 1974, 1979, 1985)
- participation in the ongoing work of changes, encouragement of bottom-up initiatives (Lamb and Davidson, 2000)
- focus on operations with autonomous sub-systems (Beer, 1972, 1974, 1979, 1985)
- technology that supports different tasks (Banck and Nyström 2005)
- a running up-dated policy, well-known and anchored as well as governing at all levels in the organization (Banck and Nyström, 2005)

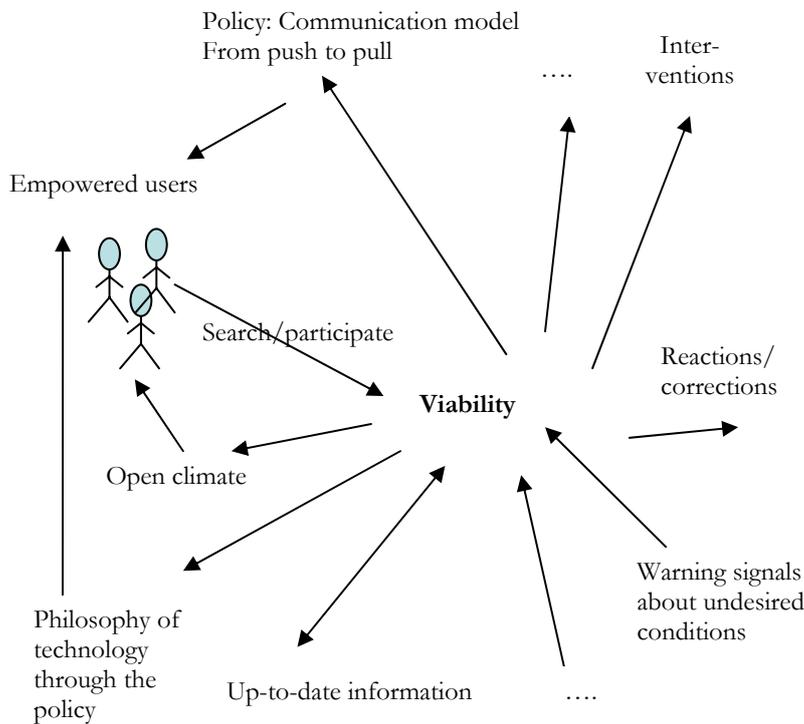


Figure 2. Different conditions necessary for viability and/or a result of viability and how these conditions are related.

These conditions are related to each other in different ways. A simplified picture of the conditions and how they are related to each other to ensure viability is shown in Figure 2 above. Participation requires engaged and empowered employees. Furthermore, empowerment is only possible if the climate in the organization is open and trustful (Telleen, 1997, 1998). Participation also requires active users in that they are curious and open-minded. The communication model in the organization must therefore focus on pull instead of push (Heide, 2002) – the responsibility to inform has moved from the traditional “sender” to the “receiver” – the user or the employer.

The view of technology as supporting tools differs among users (Banck and Nyström, 2005). Findings show that workers “on the floor” or in production, lack working tools to some extent, which are desired in daily work. Furthermore, managers and salaried employees/clerks at low levels see technology as an aid in *administrative tasks* such as booking conference rooms and publishing notes, instead of seeing technology as supporting *both* pure administrative tasks and tasks pertaining to *operations* and daily work in *production*. We can note that focus should move from *technical* to a *social* view. Such “*focus movements*” can be visualised as follows:

Table 1 Examples of different conditions dominating/existing in an organization

<i>Initial condition</i>	<i>Final (desired) condition</i>
Technical	Social context
Hierarchic	Network – empowering
Control/top-down	Open climate –trust (empowerment)/bottom-up
Passive	Active, participating
One-way	Interaction
Push	Pull
Afterward	Feed-forward

It can be noted that some of these “movements” have already occurred and some of these “extremes” are not an “either or” but rather a balancing between two “states or modes”. For example *control* must be balanced with *empowerment* although control activities implemented too early (if they are desirable at all) can in a negative way hamper empowerment (Duane and Finnegan, 2003). Top-down and bottom-up initiatives and perspectives must also be balanced so that undesired Intranet islands do not occur (Lamb and Davidson, 2000).

The “conditions/extremes” above can also be discussed in terms of embedded dimensions. For example, *passive – active* can be related to use and the view of technology. The movement from active to passive can take place by enabling employees to access parts of the Intranet that were closed to them before. The movements can also be related to information and education although findings have shown that employers are passive in spite of possibilities to actively use functions as interaction in discussions on a whiteboard. They did not know that they had the authority to write on the whiteboard (write access) (Banck and Nyström, 2005). Hence, the *push – pull* “pair” is comparable with passive–active from the perspective of communication and information. The traditional communication model (push) is out-dated and should be replaced with “pull” – users inform themselves and know that the responsibility for obtaining information rests on their own shoulders (Heide, 2002).

Afterwards – Feed-forward can both be connected to administration as well as production. A movement towards feed-forward means that there should be sensors in the organization than exception to the rule at measure the different kinds of conditions in a running mode. The measurements obtained should be compared with a map of the different conditions in the organization where desirable conditions are stated. If differences are too great some kind of signal must be engaged and some kind of control function must be made aware of the threat or what it entails. Depending on what kind of action there is, these feed-forward functions can either be implemented into an Intranet or designed as a manual function or even a totally automated function. The purpose of this movement is “it is better to react in advance than afterwards”.

The purpose and potential of technology are important issues to discuss. Speaking about new concepts might open up for new insights into this purpose. Hence, it is important to share the same language in a context when thinking about technology. Consequently, context, language, commitment and abilities of thinking and reflecting, are essential when developing, using and managing technology (Flores and Ludlow, 1981; Winograd, 1995, Nyström, 2006c).

Recommended Functions to be Implemented into an Intranet/Organization

The following recommendations are built on the assumptions mainly presented in Section 3 above.

Specific functions

Early warning system(s) are developed and implemented. Sensors or equivalents should be implemented where needed. Suitable communication channels are identified and established/implemented. This can be within the Intranet or outside if the type of EWS is not a natural part of the Intranet. Control function(s) for each EWS is/are identified and connections between them are established (communication channel). A “map” of the entire system/organization with acceptable conditions implemented is designed and is available for the Control function(s) so signals from the EWS can be understood and taken care of.

“**Gate-keeper**” is established between the environment and the organization, where information from the outside is taken care of. Some of the information is collected and some information has been sent by external sources. The information that has been collected can be handled in advance by intelligent agents – pre-programmed agents with instructions to carry out specific tasks such as search for similar course curricula exception to the rules at Swedish universities published on the web, and the ability to learn based on collected results. The information, both information to the organization and information from the organization, is further developed; aggregated, summarized, structured, and commented based on the receiver of the information. Some of these “damper/amplifiers” can be designed as automatic functions but most of them require human decisions with support from suitable functions in the Intranet.

Search functionality. Intelligent agents are developed, mainly supporting the “search” within the Intranet (Ginsburg, 2001). Ginsburg points out the advantages of the use of agent technology as a support for document management. The owner of documents can be made aware of whether or not the document has been read in the last month, and thus act on this. The use can be

expanded to issues other than document management. These agents should support search abilities in the Intranet and also put demands on the recording of information based on well developed structures and indexing. (see use modes; Damsgaard and Sheepers, 1999).

General functions

Functions for *management of long-term information* are developed and implemented. Examples of long-term information can be instructions, and policies. This type of information does not demand urgent reactions; rather it is to make the receiver aware of plans and restrictions in the future. Presentation formats, “alarm clocks/agents” and channels must be carefully considered.

Functions for *management of short-term information* are developed and implemented. This kind of information often makes the receiver aware of events and obligations in the near future. A well thought-out analysis of receivers and channels based on the importance and expected reactions of the information must be carried out. See also “functions for spreading of long-term...”.

Functions supporting *interaction and collaboration* such as whiteboards, conference systems, chat systems (instant messenger) are developed and implemented.

Functions supporting *decision-making* – simulation, data stores, calculating and presentation, are developed and implemented.

Functions supporting *daily work* with the purpose of putting the focus on operations, are developed and implemented. Examples are dependent on the kind of organization the Intranet belongs to.

In General

Both kinds of functions as described above, probably require an *implementation model* describing what to do in each “step”; identify operations in need of Early Warning Systems, identify proper/acceptable conditions, identify control functions for each EWS, implement connections between EWS and control functions. This implementation model is in need of further research.

Foundation for Supporting Intranets Through Philosophy of Technology

The concepts in the CUT-P model (Nyström, 2006c, Stolterman, 2000, 2001), *Conceptions, Use, Technology* and *Policy* can be divided into sub-concepts such as Conceptions; realistic conceptions, erroneous conceptions; Use; actual use, intended use, erroneous use, under-use, misuse; Technology; existing, under construction, within or without the organization; Policy; anchored, outspoken,

common, and so on. This model should be used as a diagnosis tool in order to make the members of an organization aware of existing view of technology in the organization. The goal of this diagnosis is to reach a common view and understanding of the technology in use. The following recommendations, based on the CUT-P model for making the Philosophy of Technology in organizations common, are given:

The recommendations for common-making of technology, are of two types: First; practical recommendations that can be carried out by being included in existing policies, and recommendations in need of further research. First: ***updating and completing of the policy*** where the CUT-P model is operationalized through instructions on how to work with the concepts in practical terms. Practical work can be in form of seminars, workshops, and so on. Examples of questions to be answered during these seminars/workshops are: *Where are the different parts of the Intranet physically? Who uses the different parts? Who delivers information to the different parts? Why? What is the purpose of the different parts? Who is in charge.* Second, the ***Intranet interface*** is to mirror and support the critical information channels. The same questions should be possible to answer in terms of interface because of the transparency of the interface. Limitations and potential are visible. Answering these questions results in a visible Philosophy of Technology where:

- ***concepts*** about technology and other employees' use of the technology are the same (or close to)
- the actual ***use*** of the Intranet is the same as the intended use
- the ***policy*** of the Intranet is visible and active
- the ***technology*** is known in terms of its limitations and potential

Work with building a transparent interface as described above requires further research because it probably involves issues such as suitable metaphors because a traditional interface might not be the best solution.

The Viable Intranet and Common making of Technology: The contributions

The findings presented in this paper have two kinds of implications/contributions: First, some tangible proposals/recommendations are given. These recommendations are directed both to practitioners as well as researchers. Second, ideas and assumptions are presented as the basis for further research where the emphasis should be concentrated on developing different kind of models. These two kinds of implications are visualized in Figure 3 below.

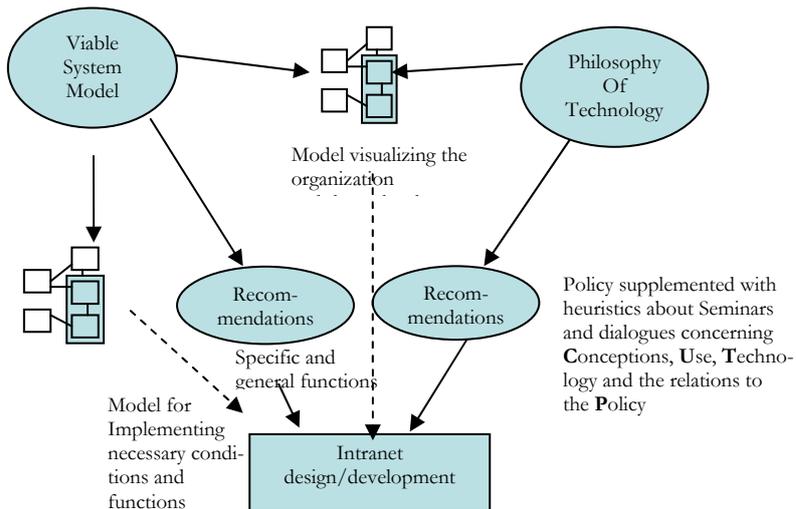


Figure 3. Implications/contributions based on VSM and Philosophy of Technology: Concrete recommendations and models that require further research.

The findings from combining the VSM, Intranet and Philosophy of technology can be summarized in four paragraphs:

- 1) Critical functions recommended for implementation into Intranets/organizations. These critical functions are divided into general functions (supporting the whole organizations and in need of further development) and specific functions supporting a given part of the organization and rather well specified (Nyström, 2006a, 2006b).
- 2) Amplification of the policy according to running development work with a dialogue concerning the CUT-P model: Conception, Use, Technology and how these are related to Policy (Nyström, 2006c).

Ideas and fundamentals in need of further research:

- 3) Model/Method for the Implementation of the functions into an Intranet/organization. Steps to be carried out could be: identification and delimitation of autonomous operational units, identification of acceptable conditions in these operational units, establishing of sensors, identification of adequate control systems, identification and design of channels between operational units and control systems. This Model/method should be further developed, preferably in an action research project.
- 4) Model of the Intranet interface where the underlying technology and the VSM as a skeleton is made visible. This interface should be transparent so

the Philosophy of Technology is visible (Banck and Nyström, 2005, Nyström, 2006c). Questions to be addressed are:

- Where are different parts of the Intranet situated?
- Who uses the information and why?
- Who delivers the information?
- Who is responsible?
- What potential does the technology offer?
- What are the limitations of the technology?
- In what way can I influence the technology and the use of the technology?

Conclusions and further research

The contribution of this paper lies in the combination of VSM, Philosophy of Technology through the CUT-P model and Intranets. Design of Intranets based on these two models increase the exploitation of Intranet technology and the potential according to empowered employers, increased participation in change processes as well as a focus on the work carried out in autonomous sub-parts instead of administrative tasks. Further research should focus on the design of an implementation model to enter these recommendations into an Intranet and organization, and a model for an interface mirroring the channels and connections in an organization and the underlying technology.

References

- Banck, B., Nyström, C. A (2005). "Intranet Use – A Study of Five Swedish Organizations". *Journal of Organizational Transformation and Social Change*, Vol. 2, no 2, 153-180.
- Beer, S. (1972). *Brain of the Firm*. Allen Lane The Penguin Press.
- Beer, S. (1974). *Designing Freedom*. John Wiley & Sons Ltd. Chichester, England.
- Beer, S. (1979). *The Heart of Enterprise*, John Wiley & Sons, Chichester.
- Beer, S. (1985). *Diagnosing the system for organisations*. Biddles Ltd. Guildford and Kings Lynn, UK.
- Damsgaard, J., Scheepers, R. (1999). "Power, influence and Intranet implementation". *Information Technology & People*. Vol. 12, no. 4, 333-358.
- Damsgaard, J., Scheepers, R. (2001). "Using Intranet Technology to foster organisational knowledge creation". In Proceedings of the 9th European Conference on Information Systems, Bled, Slovenia, 674-686.
- Duane, A., Finnegan, P. (2003). "Managing empowerment and control in an intranet environment". *Information Systems Journal*, vol 13. 133-158.
- Flores, C. F., Ludlow, J. (1981). "Doing and speaking in the Office", in Fick G, Sprague, R. (eds). *DSS: Issues and Challenges*. Pergamon Press: London.

- Ginsburg, M. (2001). "Improving knowledge Management via Effective Document Management" *system design: International Symposium on Information Systems and Engineering (ISE'2001) – Workshop: Knowledge Management Systems: Concepts, Technologies and Applications*.
- Heide, M. (2002). *Intranät – en arena för kommunikation och lärande*. (Eng: *Intranets – an arena for communication and learning*) Lund Studies in Media and communication. Doctoral Thesis.
- Jackson, M. (2003). *Creative Holism for Managers*. Wiley and Sons Ltd. UK.
- Kelly, K. (1998). *Den nya ekonomin – 10 strategier för en uppkopplad värld*. Eng titel: *New Rules for the New Economy*. Timbro förlag.
- Kling, R. (1999). "What is Social Informatics and Why Does it Matter?" *D-lib Magazine*, vol 5, no 1, <http://www.dlib.org/dlib/january99/kling/01kling.html> [accessed 2007-04-02].
- Kling, R. (2001). "Learning about information Technologies and Social Change: The Contribution of Social Informatics". *The Information Society* vol 16, no 3.
- Lamb, R., Davidson, E. (2000). "The new computing archipelago: Intranet islands of practice", in Baskerville, R., Stage, J., DeGross, J. I. (eds). *Organizational and Social Perspectives on Information Technology*. Proceedings of International Federation of Information Processing, Working Group 8.2, Aalborg, Denmark.
- Nyström, C. A. (2006a). "Demands on Intranets - Viable System Model as a Foundation for Intranet Design" in Dubois, D, M. (ed). *Computing Anticipatory Systems*, vol 839.
- Nyström, C. A. (2006b). "Design rules for Intranets according to the Viable System Model", in Flood, R., L. (ed), *Systems Practice and Actions Research*, vol 19, 523-535.
- Nyström, C. A. (2006c). "Philosophy of Technology in Organisations - A Foundation for Intranets" *Systems Research and Behavioral Science*, in press.
- Stenmark, D. (2002). *Designing the new Intranet*. Doctoral Dissertation. Dept of Informatics, Gothenburg Univ. Gothenburg Studies in Informatics, Report 21, March 2002.
- Stolterman, E. (2000). Lecture, 6-7 November 2000. Dept of Informatics, Umeå University, Sweden.
- Stolterman, E. (2001). "IT Artefacts in Design Work – How Technology Reveals Practice" in Björnstad, S., Moe, R. E., Mörch, A. I., Opdahl, L. (eds) Proceeding from the IRIS24 Conference in Ulvik, Norway, 11-13 Aug. 2001 (electronic version).
- Swan, J., Newell, S., Scarborough, H., Hislop, D. (1999). "Knowledge management and innovation: networks and networking". *Journal of Knowledge Management*, vol 3, no 4, 262–75.
- Telleen, S. (1997). "The Intranet Paradigm". <http://www.iorg.com/papers/paradigm.html> [accessed 2007-04-02].
- Telleen, S. (1998). "The Difference Between Internet, Intranet, and Extranet" <http://www.iorg.com/papers/iw/19981019-advisor.html> [accessed 2007-04-02].
- Winograd, T. (1995). "Heidegger and the Design of Computer Systems", in Feenberg A, Hannay A. (eds). *Technology and the Politics of Knowledge*. Indiana University Press: Bloomington and Indianapolis.

EMPOWERMENT AS A FACTOR FOR SUSTAINING THE CONTINUANCE OF AN INFORMATION SYSTEM

Leila Lage Humes

School of Economics, Business
Administration and Accounting
University of São Paulo, Brazil
lhumes@usp.br

Nicolau Reinhard

School of Economics, Business
Administration and Accounting
University of São Paulo, Brazil
reinhard@usp.br

Abstract. The intention to continue using (continuance) an information system has been associated to the satisfaction with its use and perceived usefulness derived from its continued use or with the irretrievable postadoption investments (sunk costs) of expertise-network systems. However, the continuance of an IS can be associated with other attributes not pointed out before. Therefore, the intent of this study is to argue that the continuance of an IS can be associated with other attributes such as its perceived utility as an empowerment tool. Hence, for the studied system the adopted research question is “how can power affect the continuance of a voluntarily adopted information system?”. Based on Foucault’s conceptualisation of power, the paper argues that the continuance of an IS can be associated with certain roles it can play as an empowering, planning and surveillance tool. In the studied system, resistance to adopt and use it could be attributed to established power structures and even boycott by actors interested in maintaining their power base, lack of resources to generalize its availability and usage difficulties or failure to realize the system’s potential. The paper concludes by enlightening the role power can play on the intention to continue using an information system.

Keywords. . IS Continuance, Empowerment, Control, post-adoption

Introduction

The intention to continue using (continuance) an information system has been associated with factors such as satisfaction with its use and perceived usefulness of its continued use (Bhattacharjee 2001) or with the irretrievable postadoption investments (sunk costs) of expertise-network systems (Tiwana & Bush 2005).

The development of an information system consumes valuable time and organizational resources. However, organizations that have enthusiastically implemented information systems may become thwarted over time with their not so effective use. Initial adoption models such as technology acceptance model (TAM) developed by Davis (1989) or the Theory of Planned Behaviour (TPB) developed by Ajzen (1991) shed no light on how to sustain the use once continuance issues occur at a more advanced postadoption stage. Since the users' motivation to continue using an information system after its initial acceptance is not a well-developed theme in literature, the intent of this study is to contribute to this research area arguing that the continuance of a voluntarily adopted information system can be associated with another factors as its perceived utility as an empowering tool for knowledgeable actors. Hence, the research question to be answered in this study is *“How can power affect the continuance of a voluntarily adopted Information System?”*.

The reviewed system in this study is SIGEO - (Budget Execution Management Information System), an Executive Information System that was developed 2 years after the implementation of SIAFEM. SIAFEM is a large governmental system implemented in 1996 in one of the Brazilian's States, the State of Sao Paulo, as its accounting and cash management system, and is basically a transaction processing system, with very limited management support tools. Therefore, SIAFEM data are regularly replicated into the SIGEO to allow data mining and customized management reporting. The use of data available on SIAFEM and SIGEO by some officials, originated a "second wave of power". Those officials were empowered thanks to their knowledge about their Departments' expenses, which allowed them to exercise control over their Departments and even over other servants' actions. The use of SIAFEM is mandatory in the State and was imposed by law. In contrast, SIGEO, first developed to assist the decision making process in the State Secretaries' Planning Departments, was voluntarily adopted also by other officials because they perceived it as a new source of power. The study of the continuance of SIGEO was part of a broader case study research concerning the implementation of SIAFEM and its institutionalisation. However, only the continuance of SIGEO was chosen to be discussed in this study.

The expected contribution of this study is a better understanding of the role played by power hindering or favouring the continuance of an information system.

Literature Review and Research Question

IS Continuance

As stated before, the factors and dimensions that influence the decision of initially adopting an information system differ considerably from those to continue using it (continuance). Initial adoption models such as technology acceptance model (TAM) developed by Davis (1989) or the Theory of Planned Behaviour (TPB) developed by Ajzen (1991) shed no light on how to sustain the use since

“prior research does not elaborate upon users’ psychological motivations “emerging” after their initial acceptance decisions... and provide a limited explanation of, and may sometimes contradict, observed continuance behaviours.” (Tiwana & Bush 2005).

In literature, users’ continuance intention is described as being related to the satisfaction with prior use and perceived usefulness of the adopted system (Bhattacharjee 2001), the gap between expectation and post-use experience (Hayashi et al. 2004), the irretrievable postadoption investments (sunk costs) (Tiwana & Bush 2005) and habit as “the extent to which using a particular IS has become automate in response to certain situations” (Limayem & Hirt & Cheung 2003), to cite only some of the contributions in this area. However, there are other dimensions, such as power and control that can be acquired through the use of the system (its continuance), that have not been explored as contributing factors to the decision of continue using (continuance) it after the initial acceptance.

The analysis of IS continuance at the individual user level is very important when considering systems that are voluntarily adopted.

Continuance has been examined by IS theorists as Zmud (1982) who classified it as “implementation of the innovation such that it becomes ingrained within organizational behaviors” , “incorporation” that, as stated by Kwon and Zmud (1987, p. 233): “... occurs when the innovation becomes embedded within an organization’s routine and when the innovation is being applied to its full potential within an organization” or “routinization” defined by Cooper and Zmud (1990) when an “IT application is no longer perceived as something out of the ordinary”. According to Bhattacharjee (2001):

“... studies acknowledge the existence of a post-acceptance stage when IS use transcends conscious behavior and becomes part of normal routine activity.”

Other theories like the diffusion theory (Rogers, 1995) also suggests that “adopters reevaluate their earlier acceptance decision” and after this, they can decide to discontinue using a previously accepted information system. However,

these studies elaborate a limited explanation of “observed continuance behaviors”. Therefore, the intended contribution of this study is to unveil the role power can play in the decision of continue using an information system.

Power

According to Pfeffer (2005), power is a pervasive concept and used to explain many different phenomena or even “used to explain that which cannot be explained by other ideas, and incapable of being disproved as an explanation for actions and outcomes”. Additionally, the same author points out that “power is dependent on context and is relationship specific”. Therefore, a person can be more powerful when compared with others in a specific social relationship, but be powerless in another environment. Moreover, the power of an agent can also be mutable and change over time. Generally, studies of power are related to hierarchical power, a well-documented theme in literature. In order to expand the discussed topic, some conceptualisations of power are stated in the following paragraphs.

Parsons (1967) understands power as a “specific mechanism operating to bring about changes in the action of other units, individual or collective, in the processes of social interaction ” (1967:299). His definition of power is related to authority, consensus and the chase of collective goals, therefore, dissociating it from conflicts of interest, coercion and force.

Giddens (1984) argues particularly against the Parsons’ conception of power. According to him, Parsons is concerned with the creation of order focusing on the economic and productive aspects of power, therefore, ignoring conflict. The definition adopted by Giddens for power incorporates conflict since power for him is “the capacity to achieve outcomes”.

According to Bloomfield and Coombs (1992, p. 462), a view of power conceptualises it as “you either have it or you don’t, you either exercise power over others, or it is exercised over you”. This vision of power is a simplistic one and was challenged by political theorists and symbolic interactionists that argued that “power resided not in people but in systems and structures”.

However, Pfeffer (2005, p. 290), states that power is “somewhat tricky to measure and operationalize.” According to him, to assess power “one must be able to estimate: a) what would have happened in the absence of the exercise of power; b) the intentions of the actor attempting to exercise power; and c) the effect of actions taken by that actor on the probability that what was desired would in fact be likely to occur.” Therefore, as stated by him, “the definition and assessment of power are both controversial and problematic.”

Another conception of power is derived from Foucault research, which led him to conceptualize the “disciplinary” power. For him, power is something that exists only in action. He also established the relationship between power and

knowledge, refuting the hypothesis that power can be exercised only through repression. According to Foucault (1980, p. 122), “the State consists in the codification of a number of power relations which render its functioning possible”. However, to pose the power relations only in terms of the State

“means to continue posing it in terms of sovereign and sovereignty...If one describes all these phenomena of power as dependant on the State apparatus, this means grasping them as essentially repressive: the Army as a power of death, police and justice as punitive instances, etc.”. (Foucault 1980, p.122).

For Foucault (1980, p. 123-125) power has to be detached from its techniques and procedures, which provide the access to the bodies of the individuals, to their acts, attitudes and modes of everyday behaviour.

His studies (1979) pointed the importance of the relationship between power and knowledge: power and knowledge are connected through discourse both as an instrument and also as an effect of power. They are applied to the individual mediated by institutional discourses. Indeed, truth is produced in discontinuous, unstable and mobile political discourses with each institution or society having its own “regime of truth”. For Foucault (1980, p.133) “truth is linked into a circular relation with systems of power which it induces and which extends it”. According to the same author (1980, p.93-94) “Power never ceases its interrogation, its inquisition, its registration of truth: it institutionalises, professionalizes and rewards its pursuit”. Knowledge creates a regime of truth. Afterwards, the application of new knowledge allows the refinement of these “regimes of truth” or even the establishment of new “regimes of truth” that are applied to individuals subjected to its domain.

This paper uses Foucault’s concept of power since the relationships of power identified in the case study were derived from unintended and not envisioned actions taken by knowledgeable agents when the system was first implemented.

Concerning the research question, the continuance of an information system has been related to a series of factors previously discussed in this paper. It is dependent not only of centralized funding, training and support, but it can be affected by other factors as the perceived use of the IS as an empowerment and surveillance tool. Therefore, the paper’s research question is:

“How can power affect the continuance of a voluntarily adopted Information System?”

Methodology

This study was conducted as an exploratory interpretive case study research. According to Walsham (1993):

“... Interpretive methods of research start from the position that our knowledge of reality, including the domain of human action, is a social construction by human actors [...]. Thus there is no objective reality, which can be discovered by researchers and replicated by others.”

Orlikowski and Baroudi (1991) add that interpretive studies “[...] try to understand phenomena through accessing the meanings that participants assign to them.” Such studies thus seek a relativistic and shared understanding of phenomena.

Information systems research can be classified as interpretive, according to Klein and Myers (1999), if it is assumed that our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools and other artefacts.

Data Collection

The information sources used in this study are historical documents (theses, books, newspapers and magazines related to the theme) as well as the laws that imposed the system and the organizational changes that were necessary to implement it. In addition, twenty-seven semi-structured interviews were conducted with managers responsible for the implementation, support staff, helpdesk team and users of the system. Each interview lasted an average of two hours, and was recorded and transcribed. Any inconsistencies or misunderstandings were discussed later over the phone with the interviewees. Hermeneutics was used as analytical approach for the interpretation of the historical documents and interviews.

The principles of the hermeneutic circle described by Klein and Myers (1999) were applied to this case study research in order to build an understanding of the phenomenon that motivated the system’s continuance and its postadoption effects.

The case study

The Brazilian Social and Economic Context

Before 1994, Brazilian governments in general had faced enormous difficulties in planning and controlling expenses, due to economic instabilities and high inflation rates. “Plano Real”, the Government’s economic stabilization program instituted in 1994, succeeded in taming inflation and thus creating conditions for an effective control of government finances and for the implementation of an efficient budget and cash management control.

When the new governor of the State of São Paulo took office in January 1995, he encountered a rather chaotic situation. The State had some 2,000 developments paralysed due to the shortage of resources and no effective expense planning, due to the lack of up to date information. Realizing the imperative need for control instruments, the Governor decided to implement SIAFEM, a new integrated

accounting and cash management system, as part of a broader administrative and financial reform, that was completed in 1996.

The State's Financial Situation before the Implementation of SIAFEM

Until 1995, extremely high inflation rates had made financial forecasts almost useless. Hence, in the State of Sao Paulo, as a rule, departments had little use for financial and budget decision-support systems. Prodesp, the São Paulo State data processing company, operated an outdated mainframe-based accounting system that could not provide timely management information. Only after the economic stabilization program of 1994, could the State consider the introduction of effective planning and financial management tools. The first tool chosen by government for controlling its expenses was SIAFEM, a system that had been developed by the Federal Government for use by States and Municipalities and was available for immediate implementation. The decision of government of implementing new IT tools was derived from the fact that the new Governor perceived early the importance of IT for the modernization of the State administration.

The Implementation of SIAFEM and SIGEO

Motivation for developing SIGEO

A Governmental law imposed the adoption of SIAFEM throughout the State Administration, as part of a broader administrative reform. It was a mandatory system since only through SIAFEM could Governmental agencies access their budget. After two years of its successful (although not always unproblematic) implementation in over 684 agencies, with about 3,000 active users, in a record time of 45 days, another system called SIAFISICO (the Registry of Materials, Services and Vendors, and a Price Databank) containing data about prices and quantities of all goods and services bought by the State Administration was developed. These two systems allowed controllers and auditors, such as the Finance Department, to implement statistical analyses of all prices paid by Governmental agencies. Aware of this effective control, agencies became much more careful with their acquisitions. Significant and highly visible financial benefits resulting from lower and more uniform acquisition procedures and lower prices appeared soon, that were highly publicized by the Governor's office.

SIAFEM and SIAFISICO are basically transaction processing systems, with limited support for management tools. Due to this deficiency an Executive Information System, SIGEO (the Budget Execution Management Information System) was developed to provide information for strategic and tactical decision

making. Since then, data from SIAFEM and SIAFISICO are regularly replicated into the SIGEO, a system with rich data mining and customized management reporting resources. SIGEO is available to all State Government Departments over the governmental Intranet. The system uses a proprietary Database Management System that requires a separate license for each local user server. Prodesp installed the system with only one license for each Department. Therefore, if a Department would like to install additional copies, it would have to pay for the corresponding licenses out of its own budget.

The Department of Finance offered SIGEO training courses to the Departments' financial sectors servants and managers. The training program was aimed at training users to work not only with SIGEO but also with all data information gathered from other State's systems.

Despite this effort and financial support, the effective level of adoption and use of SIGEO was disappointing, when taking into account all governmental efforts to boost its use. Our study explores the reasons for this situation and some of the notable exceptions.

Motivation for SIGEO Implementation

The empirical data collected bring to light that the introduction of the SIAFEM triggered significant organizational changes in all State's Departments, but the widespread use of SIGEO occurred only in some of them.

SIAFEM was imposed by law to all departments. Therefore, sovereign power was applied by State to its implementation. However, SIGEO was voluntarily adopted by Departments. The power derived from the continued use of SIGEO was based on knowledge about the Departments' expenses. The governmental discourse for imposing SIAFEM was the 'transparency' of public accounts, but the true motive to its implementation was the control of the Departments' expenses. After SIGEO implementation, some knowledgeable officials were empowered due to their increased knowledge of their Departments' expenses that provided them with (the exclusive access to) new powerful tools for planning and for surveillance over their Department managers. According to Foucault (1979), power and knowledge are connected through discourse both as an instrument and also as an effect of power. Hence, these knowledgeable actors, were using the institutional discourse of 'transparency' of public accounts to justify their intervention in their Department's management. Another argument used by them is that if they do not use their knowledge to orientate the Department's acts, they would be subjected to a governmental auditing since all data is available to government for auditing processes. Therefore, according to empirical findings in this case study, the decision of some actors to adopt and continue using (continuance) SIGEO could be associated with its role as an empowering, planning and surveillance tool.

The Secretary of Planning was one of the actors most interested in the development of the SIGEO, since after its implementation, it could develop various other local systems, to be used for State-level budget and cash flow control, planning and historical analyses. SIGEO also allowed that department to develop improved tools for preparing law proposals for budget amendments, as well as the financial and physical control of all Departments projects and contracts. The Planning Department became, therefore, a more powerful actor in governmental decisions thanks to the increased control it could exercise over the other Departments expenses and budget planning.

SIGEO was the base for other systems as the Budget Execution Report that allows the extraction of managerial reports for simulations and budgetary projections. SIGEO, as any other Executive Information System is very fragile and vulnerable since its disuse does not cause discontinuities in any business processes. However, once it is based on a transaction system that was established as an obligatory passage point, its stored data are not conditioned to its use. SIGEO is very useful for controlling secondary data input by the Secretaries. Some Secretaries as the Secretary of Culture has specific incomes derived from renting theaters or other spaces for conferences. The Secretary of Planning controls these incomes through SIGEO. The system is also useful for generating time series that are fundamental for analyzing discrepancies between the projected and the executed budget. The Secretary of Planning and the Secretary of Finance constantly controls the other Secretaries based on the information extracted from the SIGEO. Without SIGEO it would be impossible to check for the correctness of inputted data, since SIAFEM is a transactional system and does not favor any type of data summarization.

The State Audit Court makes use of SIGEO for auditing the Secretaries and the governmental expenses. Additionally, some Secretaries began auditing their expenses more carefully since any discrepancies can be easily pointed out by the SIGEO. The SIGEO data is also available through Internet. Therefore, any citizen can check the prices paid for goods and the quantities acquired by any Secretary.

In spite of the training program and the undeniable usefulness of SIGEO, most interviewees are critical of the system and find it difficult to use. The fact that it is installed on only one microcomputer in their Departments represents an additional barrier to its use. Some interviewees, such as the financial officer of the Department of Culture mentioned that when she needs special managerial reports, she prefers to request them directly from Prodesp.

In contrast, those knowledgeable actors that were capable of perceiving the importance of SIGEO as an empowerment and surveillance tool divide the organizational change history in their Departments into two periods: before and after the implementation of SIGEO.

Administrative Practices before Implementation of SIGEO

When SIAFEM was first implemented, some knowledgeable officials perceived from the beginning the possibility of combining the data now available to control the expenses of their Departments, and began to develop their own local control systems. Some of the instances stating this change are described in the following paragraphs:

- The Department of Public Security allocated servants to gather data from the SIAFEM in order to generate time series reports for better controlling its sectors' budgets.
- In the Department of Environmental Affairs, the financial manager developed stand-alone systems that were based on data available from SIAFEM. Based on the reports generated by these systems he was capable of convincing other financial sectors of the Department to make better use of their budget or to redistribute the budget surpluses among other divisions. According to him, the manager responsible for the SIAFEM implementation in his Department encouraged this behavior. For this manager and most part of the upper Government board, the control over public expenses was the most desirable outcome of the modernization program.
- In the Department of Health, the official responsible for the financial sector began developing individual Hospitals time series, in order to analyze the evolution of their expenses, make cross-section comparison and therefore gain some control over the allocation of the Department's resources. He complained about SIAFEM's limitations, which allowed him to only analyze aggregated data, without the possibility of comparing expenses among hospitals, for example, according to their nature, e.g. catering, acquisition of medical instruments, etc.

The systems developed by these officials were based on data available only from SIAFEM. With the implementation of SIGEO they could increase even more their knowledge and control over the Departments' expenses. It became feasible to classify the expenses according to their nature, favouring comparisons and the establishment of (performance) indicators. This refinement of control empowered officials based on their greater knowledge about their Departments' expenses and about individual servants' acts. SIAFEM is auditable in that it records (and allows the retrieval of) all transactions and their authors.

Based on Pfeffer (2005), it is possible to state that, without the exercise of power SIAFEM would not have been implemented. In spite of this, the new information available triggered important organizational changes and change in the role played by some actors.

Widespread Use of the System and Empowerment of Knowledgeable Officials

After SIGEO implementation, various Departments increased their control over their Department's expenses and over other servants' acts. As stated by Foucault

“power never ceases its interrogation, its inquisition, its registration of truth: it institutionalises, professionalizes and rewards its pursuit”. The widespread use of the SIAFEM and the implementation of the SIGEO led the Department of Planning and other State agencies to continuously add new management and transactional applications in order to impose control and surveillance over their Department’s expenses and other servants acts. Therefore, their power is an always changing force that is increased each time a new tool is developed. In the following paragraphs, some empirical evidences concerning this statement will be described:

- An application at the Department for Environmental Affairs uses data gathered from SIAFEM, SIAFISICO and SIGEO to create indicators that keep track of expenses (prices and quantities) incurred by the Department.
- The financial official of the Department of Health uses data available from SIGEO to manage the Department budget. Another application was developed to build time series of hospitals’ expenses, in order to monitor these expenses and detect anomalies. Although he has no formal power over hospital directors, simply by making the data available and promoting good budget practices, the financial officer was empowered and became an essential actor within the structure of the Department. Based on his knowledge about the hospitals’ expenses, he convinced the Secretary that the financial sector should receive the whole Department budget and only release resources after his approval. He mentioned that each time a director of a hospital is replaced it is necessary to explain his role as a financial manager all over again. Additionally, he mentioned the meetings he promotes every two months with all the hospitals’ managers to explain his role and the role played by the financial sector of the Department. Therefore, his power is not owned or recognized by their pairs, but it is sustained and justified by his discourse of control over Department’s expenses. As stated by Foucault (1980, p.93) “[...] in any society, [...] relations of power cannot themselves be established, consolidated, nor implemented without the production, accumulation, circulation and functioning of a discourse.” This official imposed a convincing “regime of truth” that empowered him and is justified by the acquired knowledge about the hospitals’ expenses.
- When a hospital subordinated to the Department of Health wants to purchase any goods, it has to ask the financial sector of the Department for the required resources. Once the goods are acquired, the price paid for them is compared with the data available through SIGEO. If there is a discrepancy, the financial officer of the Department advises the Secretary to question the hospital director. This official also told that he himself is capable of elaborating the complete budget for all hospitals. This is due to the fact that he not only has the time series of the hospitals’ expenses but also a copy of all their contracts with suppliers. Therefore, he provides individual hospitals with an almost finished budget plan that requires only minimal

adjustments. Hence, the financial official of the Department is empowered and can exercise power over the hospitals' officials thanks to his knowledge of the hospitals' expenses, which is refined by new data gathered from SIGEO. Therefore, this official never ceases to perfect his knowledge of the public expenses experiencing an increasing power over other managers and actors thanks to his refinement of knowledge. Thus, the availability of information also originated a "second wave of power" since some officials were empowered thanks to the use of SIGEO, which was complemented, in some cases, with the development of local systems. The adoption and continuance of SIGEO was fundamental to consolidation of this power.

The "second wave of power" can be described as the role that some empowered officials could play on their Departments. As stated above, it could be cited the case of the financial official of the Secretary of Health that could exercise power over the Hospitals' managers, controlling their expenses and controlling other servants' acts.

The same role can be played by government represented by the Secretary of Planning and the Secretary of Finance. These Secretaries can exercise power over other Secretaries controlling their expenses and their acts, surpassing the initial envisioned use of the system that was designed to be used as a planning tool.

Therefore, as stated by Foucault (1980, p. 89),

"[...] power is neither given, nor exchanged, nor recovered, but rather exercised, and only exists in action...power is not primarily the maintenance and the reproduction of economic relations, but is, above all, a relation of force."

In fact, SIGEO only facilitated the work of those officials who were aware of the new possibilities unveiled by the information available.

The financial officer of the Department of Public Security had always been a powerful actor, even before the SIAFEM and the SIGEO. In his Department, SIGEO became an administrative surveillance tool helping him control his staff and the decentralized purchases of his department. According to him, after the implementation of SIGEO, the simplification of data gathering and analysis processes led to the relocation of servants who had worked for the financial sector to other sectors. He mentioned that his increased control of the Department's expenses is motivated by his awareness of the constant surveillance exercised by the Department of Finance, the Department of Planning and the State Audit Court. In fact, each one of the systems developed by the Department of Planning and by the Department of Finance increases the potential of surveillance. Truth was produced and refined through knowledge, but the effect of knowledge was the exercise of power by some knowledgeable actors, who will continue to refine the regime of truth in order to perpetuate their power over other actors.

Therefore, the adoption and further continuance of the SIGEO was based on its utility as a surveillance tool.

In general, the Department of Finance, thanks to SIGEO, now wields increased power over all other Departments by auditing more effectively their expenses. As told by interviewees, they now have to be very careful in managing their expenses, since the auditors of the Department of Finance, when auditing a Department, have plenty of information about all their transactions.

In contrast, in some Departments SIGEO is not used. In spite of being trained to use it, one of the interviewees, the responsible for the budget planning of the State Audit Court said that the system is very complex, and the fact that it is not available on her computer makes it difficult to use. As related by her, when she needs a special report, she prefers to ask to the Department of Planning to prepare it or she prefers to gather the data from paper-based reports and to use other office tools to compose the reports she needs.

In one Department interviewed by the authors there are Sector managers who would like to make use of SIGEO, but the official responsible for the financial sector does not acquire new licenses, one possible reason being that he desires to retain control over information, perceived as a basis of his personal power. Therefore, despite having an incentive to control the expenses of their sectors, the lack of information prevents them from exercising adequate control over their expenses or manage better their budgets.

Some Research Findings

This analysis allows the conclusion that the continuance of a system can be associated to its perceived utility as an empowering or surveillance tool. SIGEO's role in information combinability is an important factor, relating to the statement by Kallinikos (2006):

“Information combinability is conditioned by a variety of social factors... Routines and meaning-driven activities in organizations are essential factors that shape to a considerable degree the forms by which already available information is acted upon, recycled, explored or recombined.” (Kallinikos 2006).

Cultural change at the Departments required more time than the technological change. The information available through the SIAFEM took a long time to be used, although servants working with budget control quickly saw the new possibilities due to the availability of information and, when the SIGEO was implemented, they became able to improve their control. However, Department officers took a longer time to devise these new possibilities.

SIGEO was readily perceived as an important tool for the modernization of (managerial control over) public administration, but only some more knowledgeable people also understood from the beginning the importance of gathering data as a means of better managing their resources.

SIGEO was built for subsidizing information to the three levels of decision making: a) strategic, represented by the Legislative power, Secretary of Planning and Secretary of Finance; b) managerial, represented by the Secretaries and the managers of governmental programs that are capable of accessing information concerning only specific areas related with their jobs; c) operational, represented by users that have access only to information related to their specific sector. Therefore, the sustenance of SIGEO was guaranteed by governmental support, but its use by managerial or operational agents was disappointing and could not be guaranteed in all Secretaries. Government could not preview the scarce use of it in some Secretaries. Hence, the continuance of an IS could not be based on the availability of resources and support. It is conditioned by other factors and dimensions as stated by this case study. Part of the governmental plans for modernizing system administration was based on the ability of their servants to use information data for planning. It could not be reached given the scarce adoption of the SIGEO as a planning tool.

After its legitimization, the expansion of SIGEO continued to be sustained by interested powerful actors (especially the Secretary of Finance, the Secretary of Planning and the Governor) enabling them to develop new independent systems. Some Departments – especially Health and Environmental Affairs – were empowered by using the SIGEO and the SIAFEM for refining their analyses. In contrast, some other powerful actors use the system more as an instrument of surveillance to audit the expenses of their Departments, but, as stated before, the implementation of SIGEO could not be considered a success given its scarce use by some Departments. Therefore, continuance of an information system has to be better studied by researchers since it can be favoured or hindered by unexpected dimensions not anticipated by its designers.

Knowledge was the base of power for some knowledgeable officials. Through the combination and use of the available data, these actors became capable of structuring their actions in order to increase their power through the knowledge derived from the information available. New knowledge permitted the refinement of truth, generating a new “regime of truth”. This fact could not be anticipated by the system’s designers. Therefore, there are some factors and dimensions that can influence the continuance of an information system and are related with cultural and social conditionants. Power is one of these dimensions. As stated by Foucault (1980),

“There are manifold relations of power which permeate, characterise and constitute the social body, and these relations of power cannot themselves be established, consolidated nor implemented without the production, accumulation, circulation and functioning of a discourse. There can be no possible exercise of power without a certain economy of discourses of truth, which operates through and on the basis of this association. We are subjected to the production of truth through power and we cannot exercise power except through the production of truth”.

According to Powell (1991), organizational structures and practices are maintained by the active efforts of those who benefit from the change.

Kallinikos (2006) coined the expression “information out of information” to designate the information available through the combination of previous available information. SIGEO and the local systems that were developed based on it allow an improved understanding of the administration of public finances. The officials who took advantage of this expansion were empowered or acquired a better control over their subordinates. Therefore, this case study is consistent with the statement by Kallinikos (2006): “each information system that is installed in order to improve an organization’s control of the contingencies underlying its operations may indeed do so but at the same time may produce information that casts new light on the basic conditions underlying the operations of the organization.”

Conclusions

In short, SIGEO was sustained by powerful actors. Additionally, some knowledgeable Secretaries’ managers decided to continue using it due to the role played by it as an empowering tool. In spite of becoming an instrument of surveillance over the Secretaries and over the governmental acts, its sustenance was not threatened by affected actors. The SIGEO data were provenient from SIAFEM, a system that was established as an obligatory passage point. Therefore, data availability was not dependent on powerful actors.

SIAFEM, the system implemented before SIGEO, was established as an obligatory passage point, therefore, its continuance was not threatened, but guaranteed by a sovereign power that was exercised by the new governor. His initial intention was to establish control over public finances. Later on, SIGEO was implemented and caused a shift in power relations mainly by increasing the power of the Secretary of Finance, the Secretary of Planning and by changing the role played by some knowledgeable managers that were empowered thanks to the good use of the available information. Therefore, they could surpass their presupposed power and extend it exercising power over their Departments and even over other servants’ acts. The government was aware of this empowerment and refinement of power, but since it helped to have a better control over public expenses, this behavior had been tolerated and was even boosted by government.

SIGEO became a governmental instrument of control and surveillance over Secretaries and servants’ acts. Additionally, knowledgeable officers made use of it as an empowerment tool and were very interested in continue using it. Therefore, the continuance of the studied system was partially resultant from its use as an empowering tool permitting some managers to exercise power over their Departments and even over other servants due to their control and surveillance over their acts. It is important to emphasize that the envisioned continuance of the system by its developers was based on the role to be played by it as a tool for optimizing Departments’ expenses and not for empowering managers.

The perceived usefulness of the system as an instrument for empowerment was an important factor for boosting its use.

Therefore, the decision of continue using an information system cannot be studied as dependent only on resources available or managerial support. There are other unexplored social and behavioural factors and dimensions that can influence the decision of continue using a system that should be analysed in future studies. As stated by Bhattacharjee (2001), the postadoption of an information system could not be based only on its initial acceptance and use.

Additionally, it can be stated that introduction of an information system in a public administration followed the stated by Dunleavy and Margetts (2000), i.e., disaggregation of previous integrated hierarchies, cut of public service costs and an increase in public service delivery. Therefore, according to Kallinikos (2006), “social practices and work patterns within which information processes develop play an important role in its combinability” and can influence its further use.

References

- Ajzen Icek. “The Theory of Planned Behavior”. *Organizational Behavior and Human Decision Processes*, 50, 179-211.1991.
- Bhattacharjee A. (2001). “Understanding information systems continuance: an expectation-confirmation model”, *MIS Quarterly*, vol. 25, no. 3, pp. 351-370.
- Bloomfield Brian P., Coombs Rod. “Information Technology, Control and Power: the centralization and decentralization debate revisited”. *Journal of Management Studies*, 29:4, July, 1992. pp 459-484.
- Cooper R. B., Zmud R. W. (1990). “Information Technology Implementation Research: A Technological Diffusion Approach”, *Management Science* (36:2), February 1990, pp 123-139.
- Davis, Fred, D. “Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology”. *MIS Quarterly*, September. 1989.
- Dunleavy P, Margetts H. (2000). “The Advent of Digital Government: public bureaucracies and the state in the internet age”. *Annual Conference of the American Political Science Association*. Washington.
- Foucault M. (1980). *Discipline and punish: the birth of the prison*. London: Penguin, 1979.
- _____. “Two Lectures”. In Gordon C. (Org.) Foucault: Power/Knowledge: Selected interviews and other writings: 1972-1977. New York: Pantheon Books.
- Giddens A. (1984). *The Constitution of Society*. Berkeley: University of California Press.
- Hayashi A., Chen C., Ryan T., Wu J. (2004). “The Role of Social Presence and Moderating Role of Computer Self Efficacy in Predicting the Continuance Usage of e-Learning Systems”. *Journal of Information Systems Education*. Available at: <http://www.cis.gsu.edu/~ghubona/info790/inf0790sumana.pdf>. Accessed on November 10, 2006.
- Kallinikos J. (2006). “Information out of information: on the self-referential dynamics of information growth”. *Information Technology & People*, vol. 19, no. 1, pp. 98-115.
- Klein H., Myers M. (1999). “A Set of principles for conducting and evaluating interpretive field studies In Information Systems”, *MIS Quarterly*, vol. 23, no. 1, pp. 67-94.

- Kohn T. H., Zmud R. W. (1987) "Unifying the Fragmented Models of Information Systems Implementation". In *Critical Issues in Information Systems Research*, Boland R., J. and Hirschheim, R. A. (eds.), pp 227-251, John Wiley and Sons, New York.
- Limayem M., Hirt S. G., Cheung C. M. K. (2003). "Habit in the context of IS continuance: theory extension and scale development". In *Proceedings of the Eleventh European Conference on Information Systems* (Ciborra C.,U., Mercurio R., de Marco M., Martinez M., Carignani A. eds.), Naples, Italy.
- Orlikowski W., Baroudi J. J. (1991). "Studying Information Technology in Organizations: Research Approaches and Assumptions". *Information Systems Research*, vol.2, no.1.
- Parsons Talcott. (1967). "*Sociological Theory and Modern Society*." New York: Free Press.
- Pfeffer J. "Understanding the role of power in decision making". In: Shafritz, J. M. J. S. Ott & Y. S. Jang (eds), *Classics of Organization Theory*, pp. 289-303, Harcourt Brace & Company Ltd. 2005.
- Powell W. (1991). "Expanding the scope of institutional analysis". In: Powell, W. W., DiMaggio, P. J. (Org.). *The new institutionalism in organizational analysis*. Chicago: The University of Chicago Press.
- Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.
- Scott R. W. (1992). "From technology to environment". In: *Organizational Environments: Ritual and Rationality*. Sage Publications, Inc.
- Tiwana A., Bush A. A. (2005). "Continuance in Expertise-Sharing Networks: A Social Perspective". *IEEE Transactions on Engineering Management*. Vol. 52, no. 1.
- Walsham, G. (1993). *Interpreting Information Systems in Organizations*. Chichester: John Wiley.
- Zmud R.W. (1982) "Diffusion of Modern Software Practices: Influence of Centralization and Formalization". *Management Science*, vol. 25, no. 10. pp 966-979.

Social and Economic Incentives in Online Social Interactions: A Model and Typology

Nikolaos Korfiatis
Department of Informatics
Copenhagen Business School (CBS)
Copenhagen, Denmark
nk.inf@cbs.dk

Abstract. This paper tackles with the theoretical background and the typology of incentives that characterize behavior in online social interactions. Online social interactions are a significant element which characterizes activity in online communities. Social network theory and behavioral concepts such as social preferences can provide an analytical framework for studying them. We contribute by introducing a typology of social, behavioral and economic incentives by formulating related hypothesis. We then combine these hypothesis in a proposed structural model from which we theorize the different classes depending on the model configuration.

Keywords. Online Communities, Social Network Analysis, Incentives.

Introduction

The incremental adoption of the web as a communication channel has resulted to a broad variety of online communities (groups of individuals with dense amount of social interactions over the internet) that dramatize a significant role into several application domains (e.g. opinion forums, online auctions etc). In this diversity of communities, there are cases where online social interactions are not only a way of communication but act as an enabler of transactions (e.g. in the case of online auctions) where in that case no contractual enforcement is present.

Conversely unless there is a formal protocol, a significant problem of these online communities is the issue of participation both in terms of membership and activity. In particular those online virtual environments require a certain amount of members or a “critical mass” in order to have some activity and thus retain their members. Nonetheless although there are profound flexibilities to form interaction (e.g. related with geospatial distance), this type of virtual communication is quite difficult to be formed in a non-ad-hock way. As (Finholt & Sproull, 1990) indicate, technological solutions that enable communication over the internet, address only the infrastructural solution to this problem.

An important perspective on online communities’ research is the behavior of the participant and the incentives that affect it. In the literature there are several studies that try to outline what are the incentives for participation and thus explain the behavior of individuals that participate on these online social groups (Jones, Ravid, & Rafaeli, 2004; Kollock, 1999). However there is little empirical evidence regarding *the nature of the incentives that affect participation on online communities* and their significance to the output. In principle we can classify incentives into two major groups: social/behavioral and economic. Social incentives study the way group interaction patterns are formed by taking a holistic view of the interaction structure and behavior under certain viewpoints (e.g. activity). On the other hand, economic incentives try to explain behavior by theorizing a rational agent model of the participant. That is, in the case that the individual’s objective function is to seek relevant information then a way to maximize his/her utility is by participating in a community.

Nonetheless empirical evidence may contradict this direction. One could argue that since members receive no profound compensation for their participation they have a high opportunity cost. For example an expert who participates in an online community (e.g. a forum of computer programmers) and spends a lot of time for answering to complex questions might have a high opportunity cost depending with his offline activities and the compensation he receives by doing them.

Similar to the later, one of the much cited problems in the case of communication activity is the factor of the membership size (Butler, 2001). As a club or a union, an online social structure in order to operate appropriately it

needs a critical mass of members. Related to that is the problem of activity. While due to design settings people are obliged to become members of a virtual community in order to participate, there are several cases where activity unless is obligatory (e.g. in terms of a community facilitating transactions such as e-bay) is not directly affected with membership size. This phenomenon has been placed in computer mediated communication literature as “lurking” (Preece, Nonnecke, & Andrews, 2004; Rafaeli, Ravid, & Soroka, 2004). Lurkers are individuals who although participate formally in the community they are not active. An online community with a high amount of “lurkers” has an activity problem which results to a low quality of social interactions between the members.

This research is motivated from an analytical view of social interactions involving studies of social positions and their apparent relation with incentives of participation. We contribute to the understanding of social interactions on online environments from a perspective deploying both social and economic incentives in a dyadic and group dimension in order to explain participants’ behavioral properties. Furthermore we develop an analytical model and formulate the related hypotheses that relate the different factors that affect behavior in online communities.

In particular, drawing from the related literature our ongoing research tries to answer the following: (a) How can the key factors that affect behavior on online communities be classified in Social and Economic terms (b) Do social factors matter more than economic ones? (c) Is there a (casual) connection between them?

At that stage of this research in progress, this paper is trying to provide a typology and a set of hypotheses by summarizing the related literature. To this end this paper is structured as follows. Section (2) provides a background on studying online communities and the social interactions that characterize the activity of their members. Section (3) provides a typology of the incentives/factors that characterize participation on online communities by classifying them into two categories: social and economic. For each type we formulate a hypothesis that relates this factor to the behavior of an individual who participates on an online community. Section (4) provides an overview of a structural equation model that we theorize based on the hypotheses that we develop on section (3). Finally section (5) provides discussion and possible ways of operationalization of the model and its empirical validation.

Studying Online Social Interactions: A theoretical Overview

An online community can be defined as an asynchronous communication channel where individuals exchange information following a set of rules which are

defined in the communication protocol (Rheingold, 2000). The communication protocol dictates the way by which the communication parties interact. A community mechanism facilitates the interaction between the individuals by providing the necessary tools for (a) Identity management, (b) Organization of activities and (c) Facilitation of interaction (Koch & Wörndl, 2001).

Identity management refers to the infrastructural capability that an individual has in order to manage his/her identity inside the community, as well as the capability for the community administrators to track the membership. For instance Google Groups¹ has a subscription process which someone must follow in order to register on a specific group. While some communities allow open participation in terms of monitoring of activities (e.g. reading the discussions in a newsgroup), the majority of them require registration in order to participate (e.g. start posting questions). Several members prefer to hide their identity using pseudonyms due to privacy reasons although in some communities, the notion of trust is important and the pseudonyms might have a social cost at some point (Friedman & Resnick, 2001). For instance in the case of online auctions (e.g. e-bay) where the primary interaction is transaction dependent, communication is also an important element due to the fact that is enabler of trust among the sellers and buyers.

On the other hand, the part related with the *organization of activities* addresses the infrastructural side of the community. In particular it provides the communication protocol between the members. For instance in the case of an internet newsgroup the protocol dictates that in order for someone to receive an answer he has first to send a request. Communities also provide tools that facilitate interaction and make it more usable for the end-users/individuals. For instance a threading feature on an internet newsgroup is useful because it organizes the information according to the topic or by the date. This part has also to do with the usability issues that someone may come up when using the community site. Usability issues are also a critical success factor for the development of a virtual community (Mynatt et al. 1997).

Although communication activity in an online community is group-based, most of the interactions that are facilitated are hierarchical or dyadic. For instance let us revisit the case of the internet newsgroups. A dyadic hierarchical way of interaction means that someone posts a request and several others reply to the individual and not to someone else thus creating a discussion thread. Then the individual establishes a virtual interaction with each one of the answerers but there might be cases where answerers interact between them during the thread/discussion. For instance an individual (*A*) is posting a question in a group and receives answers by four members (*B*, *C*, *D*, and *E*). As can be seen in the

¹ <http://groups.google.com>

example pattern in Figure 1 individual *A* receives a direct answer by the individuals *B*, *C*, *D*, and *E* and forms a dyadic relation with each one of them.

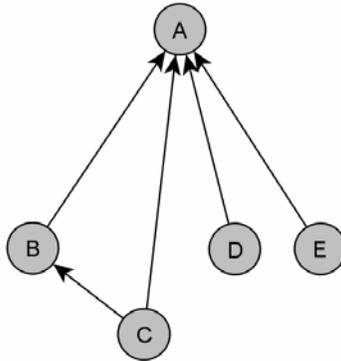


Figure 1: An interaction pattern representing a thread of an internet newsgroup

However individual *C* also forms a dyadic relation with individual *B*. This might be the case where *C* is commenting on *B*'s answer by providing as well his answer to the message posted by *A*. Dyadic relations formed among individuals on online communities provide a fruitful way of assessing activity by using established concepts and techniques from the domain of analytical sociology and in particular social network analysis.

Social Network Analysis

As aforementioned online communities facilitate social interactions which regardless the activity context, require a concrete methodological formalization that may allow for inter-context studies of the behavior. One of the most suitable methodologies for observing social activity and modeling the interaction of individuals in a social group is Social Network Analysis (SNA). SNA has been established as a concrete methodology resulting from social psychology and communication studies (Wasserman & Faust, 1994). The growing amount of SNA research done in organizational context (Borgatti & Foster, 2003) supports a broad positivistic view on the study of technology oriented phenomena by using the formalism provided by SNA and Structural Analysis in general (Zack, 2000).

One of the basic assumptions of social network analysis and in general the part of sociology that relates with “structural” analysis is that the topology of an individual (actor) on his/her network of contacts/relations has a profound effect to his/her behavior (Scott, 2000; Wasserman et al., 1994). In order to model social interactions in an online community as a social network, we first need to classify the two major types of network variables namely the *structural* and the

compositional variables. Table 1 summarizes some of example operationalization of these variables. Structural variables form the core of the network and contain a dyadic record of social interactions between two actors that belong on the same network. By drawing the set of the structural variables we have the complete network. Nonetheless structural variables describe only the relations and not the individual characteristics of the actor. This role is undertaken by the compositional variables which provide a way for expressing actor related attributes such as demographics etc.

	Type of Variable	Operationalization
Focus on the group	Structural Variables	Interaction between individuals, friendship, business alliance etc
Focus on the Individual	Compositional Variables	Individual Reputation, Demographics, Activity frequency etc.

Table 1: Structural and Compositional Variable in Social Network Analysis

Apart from the variable definition, In order to construct a social network, one has to define the unit of observation from which the structural variables of the social network will be constructed. Due to the fact that SNA tackles with the topological properties of the unit of study we have the flexibility to follow the same set of methods regardless the size or the nature of the unit. For instance we can seek for exchange patterns with the same analytical methods both for individuals and institutions. In relation with the unit of observation we proceed with the “relational quantification” of the social network which defines the way the relational ties in the structural variables of the network are formed. Depending on the nature of the network a relational tie can be either directed (directed network) or reciprocal (undirected network). The relational quantification is also subjective to the research question that we follow. For instance if we are interested to examine information flow among individuals in online communities then the obvious way is to model it with as a directed network. However if the research question is broader for instance in the case of membership then an undirected network is more suitable. Relational quantification also depends on the network data available.

Nevertheless in order to have a concrete understanding of social interactions we have to take a broader look on dyadic interactions and their nature. The section below provides an insight on the nature of dyadic interactions.

The Weak Ties hypothesis

Central to Social Network theory is the weak ties hypothesis that was first discussed by Rapoport (Rapoport, 1954) and later formalized by Granovetter (Granovetter, 1973; Granovetter, 1982) in the context of a job search network in a labor market. Essential to the weak ties hypothesis is the idea that there might be cases that the structural variables considered do not actually provide a realistic view of the network structure. In particular, there might be contexts where the abstract formalism doesn't consider different forms of strength regarding the relational ties which are formed between members of the network. In fact this formalization doesn't distinguish between the strong and weakest forms of relational ties. Based on the particular strength or weakness of the relational ties there can be assumed cases of influence/obedience or isolation of the individual from the group and this effect to the social interactions that are already formed.

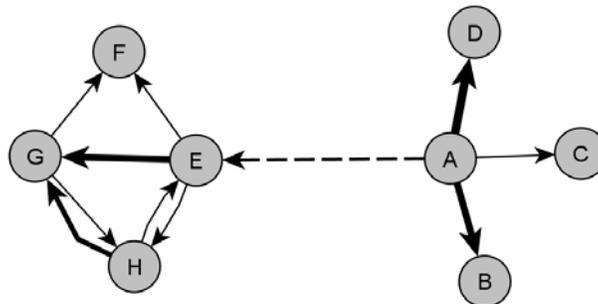


Figure 2: According to the hypotheses, weak ties (dotted) act as bridges between strong dyadic relations

Nonetheless defining a strong or a weak relation in an online setting is a matter of great complexity. Several sources of interactions could be used to define weakness or strength of a tie in a dyadic structure. Granovetter (Granovetter, 1973: page 1361) in his original formalization argues that the “*strength of a tie is a supposedly linear combination of the amount of time, the emotional intensity, intimacy and the reciprocal services which characterize the tie*”. For example in the case of an email network we could consider the number of emails those two persons have exchanged as an indication of social activity between them, thus being positive correlated with the strength of their social connection as a longitudinal effect.

According to that perspective, weak ties may act as bridges over time, between strong dyadic relations thus positioning an important role in the network structures by bridging strong dyadic neighborhoods of the network. Weak ties affect the cohesion of the group which in turn affects the activity. It is more likely that a group with strong cohesion will be more active and “energetic” than a

group with a weak one. This is because a weak tie is more likely to expose its weakness in an isolation from the other entities of the structure. However it often reestablishes itself with another destination. The possibility of this to happen depends on context dependent properties such as affiliation with a third party or a common activity.

A typology of Incentives of individual Behavior in Online Social Interactions

So far we have reviewed the underlying concepts which formulate the theoretical background of our approach. In the next section we consider special cases of the theoretical concepts described above in order to explain behavior in online social interactions.

In order to frame better our research objective we theorize our typology on a community that exchanges information using the mechanism of an internet newsgroup. In that case the interaction protocol dictates that a member posts a question and other participants reply to that question or comment the answers that someone else has provided in relation with that question. The interaction pattern is the same with that of Figure 1. Based on theoretical and empirical work, we structure our typology in two groups that can be operationalized as constructs and latent variables in an empirical partial least square (PLS) model.

Social/Behavioral Incentives

Having discussed the cases of dyadic ties in the context of social network analysis we discuss both social and behavioral cases that might affect the nature of relational ties and the behavioral outcomes of an individual participating in an online community. Social incentives relate with the network position (structural variables) while behavioral relate with compositional variables that affect individual's behavior.

Inequity Aversion

Experimental evidence in behavioral game settings indicates that a significant portion of individual's behavior is controlled by an aversion to "inequity" or "inequality". Inequity or inequality aversion addresses the case where individuals resist to inequitable outcomes and their constant behavior is controlled by that. Fehr and Schmidt (Fehr & Schmidt, 1999) provide a set of theoretical and empirical explorations as well as experimental evidence where they define two types of inequity aversion:

- The *disadvantageous inequity aversion* or “*envy*”: Where individuals dislike the case where other individuals receive more compensation than them
- The *advantageous inequity aversion* or “*overcompensation*”: Where individuals dislike the situation where they feel that they receive more than the other individuals.

Inequity aversion can be observed in any setting that involves exploitation over a common good. For example, in the case of an online community an individual might feel envy where another individual receives more relevant answers and in faster period than him/her. While an individual might also feel overcompensated if the quality of the service is more than he/she expects to have. Inequity aversion is a useful model to explain whether the behavior of the individual is affected by the general group behavior and thus explain attitudes towards the other members of the groups based on group outcomes. Following the model of the inequity aversion we formulate the following hypotheses:

- **Hypothesis 1(H1):** Members are willing to answer a question due to the overcompensation effect of their service.
- **Hypothesis 2(H2):** Members are less likely to respond to an answer if they haven't received a response to theirs which exploits their envy.

Inequality aversion has not immediate effects but evolves over time; therefore it should be treated as a longitudinal effect.

Reciprocity

Reciprocity is a fundamental structural concept that relates dyadic relations with the behavioral outcomes. It is both a structural and behavioral topic that is often addressed with offline interactions. As can be also observed in offline settings, individuals participating in an online community tend to reciprocate the behavior or service they received from another individual during their participation in the online community (Fehr & Gächter, 1998). By receiving a conceivable good service by another individual individuals feel a debt to that and have a tendency to reciprocate. This is largely influenced by offline cultural settings and the interpersonal communication factors characteristics that may affect it (e.g. personal contact etc). However an interesting case to study reciprocation on these settings is the degree of anonymity that is provided under pseudonyms. Based on that fact we formulate the following hypotheses:

- **Hypothesis 3(H3):** An online community member is more likely to answer to a question of another individual if that individual has provided an answer before.
- **Hypothesis 4(H4):** An online community member is more likely to not participate if he hasn't had an interaction with that individual before.

In fact both H3 and H4 examines whether an online community member feels a debt to another individual that has provided an answer before or not. This is also dependent to the membership size controlling that there is the possibility of this interaction to take place over time. Reciprocation can be treated both as an immediate or longitudinal phenomenon controlling for a repeated dyadic bi-directional relation (Reciprocation of A-B is B-A).

Reputation Effects

Reputation as a social incentive relates with the status of an individual in the community and the perceived importance that he/she processes by the activity inside the community. At that case an individual would want to sustain his/her reputation and thus behave accordingly. We highlight two types of reputation: group perceived reputation and individual status. Group perceived reputation relates with the reputation/status that the individual possess inside the group as a whole. Individual status relates with the reputation in the individuals ego centric network. That is the network of first and second degree acquaintances in the part of the group that he is active. For instance someone may be active in some topics in the newsgroup and thus reputable on these however he/she might not possess the same status in the whole. Following these theoretical assumptions we formulate the following hypotheses.

- **Hypothesis 5(H5):** An individual will answer a question in order to increase or maintain his/her status in the community
- **Hypothesis 6(H6):** An individual will answer a question if he considers that it will increase his/her visibility in the network.

Both the above behavioral factors are subject to a broad case known in behavioral research as the “*end-game effect*”. The end-game effect denotes the negative influence of the prospects of the individual in his/her actions and the outcomes. In particular an individual under the end-game effect will try to be as much opportunistic as he can. This can be observed under longitudinal settings where the observed behavior at time t_1 will be totally different from the observed behavior at time t_2 , due to the fact that status will not have a value anymore.

- **Hypothesis 7(H7):** If the online community member is not going to participate in the community anymore then he/she is not motivated by his/her status

Preferential Attachment

Preferential attachment follows the theoretical assumptions of the triad closure in order to provide an understanding of interaction network growth. In particular that case denotes the willingness of an individual to join an existing active thread where he considers that there might be a higher probability to get a reply rather than using a thread of low activity. Following that theory we can formulate the following hypotheses:

- **Hypothesis 8(H8):** Individuals tend to participate to threads that have already a considerable amount of responds
- **Hypothesis 9(H9):** Individuals avoid becoming the first to reply to a question posted.

Preferential attachment might also be negatively correlated with shyness or exposure aversion. This can be interpreted as the case that a community member doesn't want to be exposed because he/she is not confident about his/her reply.

Membership Size

Community size affects directly the significance of reputation for an individual. Since reputation provides a way of social ranking it is logical that the higher the amount of people in the social group are then the higher is the significance of their reputation. Assuming that reputation is positively related with the membership size of the community then the higher the community size the higher the reputation. Thus we formulate the following hypotheses:

- **Hypothesis 10(H10):** Membership size affects positively the reputation incentive for an individual to contribute
- **Hypothesis 11(H11):** Membership size is a negative factor for the reputation incentive

Economic Incentives

So far we have examined cases where participation is motivated by factors which are not directly connected with *an individual's utility function*. As aforementioned we make the assumption that a participant in an online community follows the rational agent model which dictates that he/she has as an

objective the maximum utility that can be provided by the participation in the community. In that case we theorize those factors that have a negative reciprocal connection with participation in an online community since research designs that deal with the case of providing monetary rewards for online activities is out of our research scope.

Opportunity Costs

The concept of opportunity cost addresses the “potential” loss of benefits that the individual could gain if he/she was not participating in the community. An obvious way to measure opportunity cost is through time consumed during the participation. If someone who participates in a community by providing answers loses a lot of time in order to maintain his/her presence then his/her opportunity cost is a function of the time spent in the community and the activities that could be done by this individual which could compensate him better for his/her participation. One particular issue with the opportunity cost is that it is not easy to measure due to the fact that the compensation for the members of the community might be different referring to the set of other activities that could be accomplished by participating in other activities (e.g. free time, opportunities to participate in offline activities with friends and family etc). As discussed in the introduction the opportunity cost might affect negatively the activity in an online community, thus we have:

- **Hypothesis 12(H12):** The higher opportunity cost the less is the online activity for an individual

Knowledge Acquisition Costs

Knowledge acquisition cost relates to the individual’s effort of acquiring the information/knowledge required to address the post as well as his/her experience in the topic that the community is facilitating. Theoretically this can be compared with search costs (Nelson, 1970). This can be related with both the behavior in the community and the opportunity cost as well. It is more likely that high knowledge acquisition cost influences positively the opportunity cost as well. Thus we have:

- **Hypothesis 13(H13):** The less the knowledge acquisition cost the higher is the likeliness to participate in the community and answer a question
- **Hypothesis 14(H14):** The higher is the knowledge acquisition cost the higher is the opportunity cost of an individual

Knowledge acquisition cost is valued by actions that take place outside the community and has an immediate effect controlling for the individuals ability to reply to a topic.

Evidence of Previous Activity and Tragedy of the Commons

Previous activity is a longitudinal construct that refers to the perceived group activity by the individual at a specific point of time. For some individuals high communication activity is also a factor of lurking due to “tragedy of the commons” effects (Hardin, 1968). In that case if an individual participates in a group with a high amount of members then he/she perceives that fact that there will be the belief that there will be other community participants that they will provide a reply to a message posted by someone.

- **Hypothesis 15(H15):** The higher is the communication activity of the group at the time the individual wants to participate then the less is his/her willingness to do so.
- **Hypothesis 16(H16):** The higher is the communication activity of the group at the time then the individual participates to the threads that are more active.

H16 in fact relates previous activity with preferential attachment where individuals tend to participate to topics with high activity.

A Structural model of Social and Economic Incentives

Having summarized the factors we consider as influential to an individuals behavior in an online community, we construct an empirical model that can be evaluated empirically in a later stage. In our model we reflect on a set of control variables in order to study “ceteris paribus” changes to the behavior under specific settings. In particular the main control variable derives from the fact that whether the individual is in position to answer a post by another individual. That is whether or not feels capable by doing that. As can be depicted in Figure 3, we operationalized the hypotheses discussed above in two groups: those that have longitudinal effects (e.g. after some time) and those that have an immediate effect. In that case we consider time as a control variable as well.

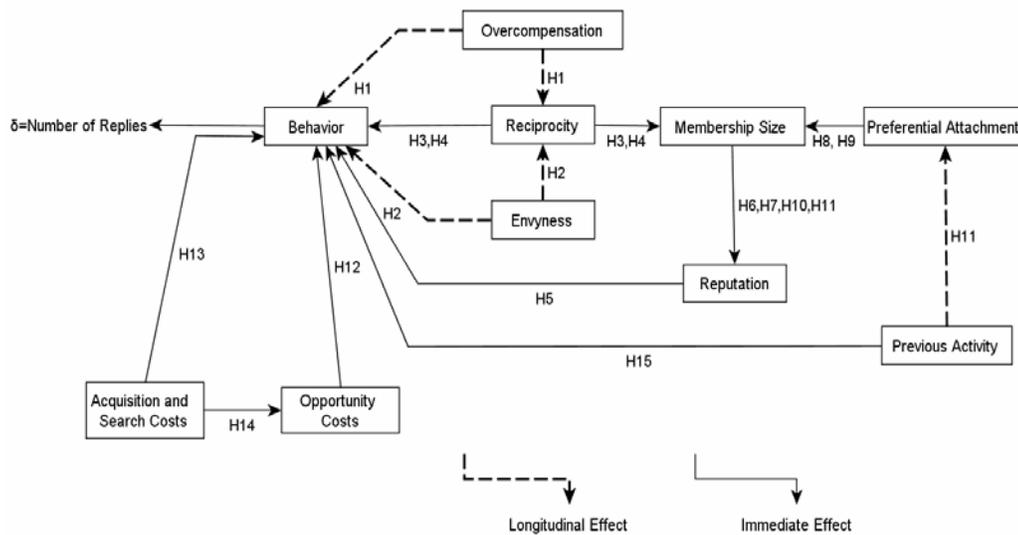


Figure 3: The proposed empirical model with the related hypotheses and constructs.

Formally we consider the “behavior” of the individual as an exogenous latent variable which can be operationalized for instance by the number of replies this individual posts to the community. Based on the different configurations of the proposed research model we are able to identify classes of behavior in an online community.

The Selfish

The “selfish” is this class of members of the online community that seek to maximize their benefit by participating in the community and being as less active as they can. Judging from the fact this class of individuals is likely not to care about reputation in the community due to the fact that are not willing to maintain a status or find beneficial to possess a reputable one (H5 is rejected). H2 (disadvantageous IA) may be supported due to the fact that this class of contributors is trying to exploit as much as they can and might feel disadvantageous or competitive over those who have achieved that. Similar to that support of H1 (advantageous inequity aversion significance) may not be supported due to the fact that overcompensation may not appear to this class of members.

The hypothesis connected with opportunity and acquisition costs should be rejected since the members are likely to not contribute if they feel no debt about it. However a special case of selfish behavior might also be in the case that some of the hypothesis H6, H7, H10 or H11 can be supported (*ceteris paribus*) due to the fact that selfish behavior might be mirrored in actions that keep the reputation high without providing much value to the other community members.

A special case can be also the factor of the knowledge acquisition cost. In particular if someone had a high knowledge acquisition cost to obtain this knowledge then he/she might not consider sharing that with others due to disadvantageous inequity aversion (envyness over the potential benefactors of that information).

The Altruists

The opposite case of the selfish members is mirrored to the Altruists. Altruists are those members that consider having little opportunity costs by participating in the community and being active on it. Due to this, connection between opportunity costs and knowledge acquisition costs may not be supported. Also a special case of altruism may be in the case H1 can be supported (conditional altruism). H1 may also expose a degree of morality due to the overcompensation over the group resource to the individual. Reciprocation is another characteristic factor that is supported in a fixed effect basis. That implies that an altruist will always act reciprocally over positive cases and will not consider previous activity as a condition to participate. In the case of IA members who have received a lot from the community feel overcompensated and therefore they try to give back. This can be seen as a case of generalized reciprocity since the effect is not immediate but longitudinal.

Altruists may be affected in a longitudinal way by previous activity due to the fact that high activity implies a certain degree of interactions which might expose altruism in the case of knowledge/information sharing. Also the direct connection of Acquisition and Search Costs (H13) will not be supported due to the fact that this class of users judges little over their personal experience when they contribute to the community/group. In fact some of the group members may act altruistically in order to help other group members adverse the knowledge acquisition cost that they have overcome before. Altruists are of high value to the community since they create value in return of very little compensation (opportunity costs, reputation).

The Reputable

Reputable users consider reputation in the community as of high value and judge their behavior accordingly with the aim of maximizing their positive presence in the community and thus their reputation. This is a case that is an averaging between the selfish and the altruists due to the fact that their behavior is self maximizing but the means they use are altruistic in the sense that they act with the aim of getting exposed as members with a high value to the community (H3, H4).

This class of users will (positively) reciprocate conditionally a behavior if they consider it as an input to their reputation, regardless their knowledge acquisition

cost (H13 rejected). Preferential attachment (support of H11, H8, and H9) will affect their behavior due to the fact that they will seek ways of getting positively exposed to a large number of participants and maintain a public profile that is visible to a large number of members. For instance in communities where reputation plays a significant role (e.g. Slashdot) members might want to participate to threads with large activity due to the fact that they might get exposed to several members who will value this characteristic over their judgment (backward induction of previous activity, H11 highly supported).

Maintaining reputation might be costly (depending of the member's objective due to participation in the community) since might result in high opportunity and knowledge acquisition costs. For instance if someone in the community is considered as a very knowledgeable person he/she might have a high acquisition costs of the information required to maintain his profile. This will result to high opportunity costs as well (H13, H14 supported).

Limitations and Further Research

The model presented here represents a preliminary configuration which might change depending on the research setting applied for. In particular we consider the contribution presented in this paper as a starting point regarding the development of a concrete empirical framework that will be in position to explore further the relation between social, behavioral and economic incentives. In particular some of the factors discussed here such as the Inequity aversion and Knowledge Acquisition costs might be difficult to extract under field settings. Therefore we are exploring the direction of applying laboratory experiments as a way of elicitation of this kind of behavioral/economic properties.

Social Incentives on the other hand, due to the fact that are dependent upon recordable interactions might be easier to extract and study in social network settings (e.g. the case of mutual dyads in connection with reciprocity). We can extend our theoretical case further by using social network metrics as operationalization of variables such as reputation and reciprocity.

Although some theoretical background has been given in relation with social network analysis, our hypotheses should include other theoretical implications from social networks analysis such as the case of structural holes (Burt, 1992). It is important though to theorize which type of communities we model since not-information based communities such as e-bay may be affected by other kind of incentives (e.g. supply and demand side factors) that affect activity as well.

We believe that the potential of this research can be used in several studies related with the information systems field and in particular the connection between behavior and technology. This in combination with empirical evidence can provide an analytical positivistic view on how social interaction activity is dramatized in online communities.

Acknowledgments

The author acknowledges financial support from the DREAMS project at the Copenhagen Business School. Dreams is a project funded by the Danish Research Agency under grant number 2106-04-0007.

References

- Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management*, 29(6), 991-1013.
- Butler, B. S. (2001). Membership size, communication activity, and sustainability: A resource-based model of online social structures. *Information Systems Research*, 12(4), 346-362.
- Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard University Press.
- Cummings, J. N., Butler, B., & Kraut, R. (2002). The quality of online social relationships. *Communications of the ACM*, 45(7), 103-108.
- Dellarocas, C. (2003). The digitization of word of mouth: Promise and challenges of online feedback mechanisms. *Management Science*, 49(10), 1407-1424.
- Fehr, E., & Gächter, S. (1998). Reciprocity and economics: The economic implications of homo reciprocans. *European Economic Review*, 42(3-5), 845-859.
- Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, 114(3), 817-868.
- Finholt, T., & Sproull, L. S. (1990). Electronic groups at work. *Organization Science*, 1(1), 41-64.
- Foster, C. C., Rapoport, A., & Orwant, C. (1963). A study of large sociogram: Elimination of free parameters. *Behavioral science*, 8, 56-65.
- Friedman, E. J., & Resnick, P. (2001). The social cost of cheap pseudonyms. *Journal of Economics & Management Strategy*, 10(2), 173-199.
- Godes, D., Mayzlin, D., Chen, Y., Das, S., Dellarocas, C., Pfeiffer, B., et al. (2005). The firm's management of social interactions. *Marketing Letters*, 16(3), 415-428.
- Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology*, 78(6), 1360.
- Granovetter, M. (1982). The strength of weak ties: A network theory revisited. In P. V. Marsden, & N. Lin (Eds.), *Social structure and network analysis*. Sage Publications.
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162(3859), 1243-1248.
- Jones, Q., Ravid, G., & Rafaeli, S. (2004). Information overload and the message dynamics of online interaction spaces: A theoretical model and empirical exploration. *Information Systems Research*, 15(2), 194-210.
- Koch, M., & Wörndl, W. (2001). Community-support and identity management. *Proceedings of the European Conference on Computer-Supported Cooperative Work (ECSCW2001)*, Bonn, Germany. 319-338.
- Kollock, P. (1999). The economies of online cooperation: Gifts and public goods in cyberspace. In M. Smith, & P. Kollock (Eds.), *Communities in cyberspace* (pp. 220-239). London: Routledge.
- Mynatt, E. D., Adler, A., Ito, M., & O'Day, V. L. (1997). Design for network communities. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 210-217.

- Nelson, P. (1970). Information and Consumer Behavior. *The Journal of Political Economy*, 78(2), 311-329.
- Preece, J., Nonnecke, B., & Andrews, D. (2004). The top five reasons for lurking: Improving community experiences for everyone. *Computers in Human Behavior*, 20(2), 201-223.
- Rafaeli, S., Ravid, G., & Soroka, V. (2004). De-lurking in virtual communities: A social communication network approach to measuring the effects of social and cultural capital. *Proceedings of the 37th Annual Hawaii International Conference on System Sciences, 2004*.
- Rapoport, A. (1954). Spread of information through a population with socio-structural bias: III. suggested experimental procedures. *Bulletin of mathematical biology*, 16(1), 75-81.
- Rheingold, H. (2000). *The virtual community: Homesteading on the electronic frontier* MIT Press.
- Scott, J. (2000). *Social network analysis : A handbook* (2nd ed.). London ; Thousands Oaks, Calif.: SAGE Publications.
- Wasserman, S., Faust, K., & Iacobucci, D. (1994). *Social network analysis : Methods and applications (structural analysis in the social sciences)* Cambridge University Press.
- Zack, M. H. (2000). Researching organizational systems using social network analysis. *Proceedings of the 33rd Annual Hawaii International Conference on System Sciences*, Hawaii, USA.

Business Value Created by B2B Mobile Services

Miira Juntumaa

Helsinki School of Economics, Finland

miira.juntumaa@hse.fi

Abstract. The purpose of this paper is to look at the potential business value created by B2B mobile services. The use of mobile applications has been increasing both on an individual as well as organizational level and mobile applications is a growing area for research. So far, research has been conducted on IT business value but as the use of mobile applications has been increasing, there is also need for some evidence of business value created by mobile applications and for a valid way to measure it. This paper contains a brief literature review on earlier research on B2B mobile services and IT business value aiming to propose a new, preliminary framework for future research. A six-dimensional framework of IT business value (Tallon et al. 2000) is combined with a classification of B2B mobile services (Varshney and Vetter 2002) to demonstrate the potential value created by B2B mobile services. Mobile services are still more personal in nature than more traditional IT applications and thus the business value created by mobile applications should be first looked at the user level.

Keywords. B2B, Mobile services, Mobile applications, Business value.

Introduction

The term productivity is not new, as at the start of the industrial revolution factory owners needed to assess results quickly and productivity was simply measured as output divided by input. The value created by Information Technology (IT) has been a matter of interest for as long as organizations have been utilizing IT. “Productivity paradox” during the 1980’s claimed that IT did not improve productivity (Brynjolfsson and Hitt 1998), productivity is only one form of value. but since then there have been somewhat contradictory findings on value created

by IT. For example Genefen and Ragowsky (2005) studied the benefits of ERP (enterprise resource planning) systems finding evidence that the perceived benefits may depend on the particular type of benefit and the particular need addressed, showing stronger explanation on the perceived benefit at a specific module level, than the whole organizational level. Tallon et al. (2000) also found that organizations using evaluation methodologies or measures more extensively, perceived higher payoffs from IT.

The purpose for organizations to use IT in general has traditionally been to improve its processes and productivity. To do things more efficiently, organizations increasingly aim to utilize new technologies, new devices, as well as new software. While electronic commerce continues to influence the global business environment, technologies and applications are beginning to focus more on mobile computing and wireless web (Tarasewich et al. 2002). Now the development of mobile applications and wireless web can make changes to the way of working, to where and when people work. Furthermore, mobile technologies can enhance business efficiency by distributing information to the workforce, and by offering new communication channels with customers (Leung and Antypas 2001). Byrd et al. (2006) conclude that planning the use of Information Systems (IS) might become more important since there is an extreme amount of applications in IS technology that could be fitted into the organizational strategy, such as personal digital assistants, web services, enterprise resource planning systems and so on.

In addition to the computers people have at home, IT resources have typically been located in office or other work premises and their use also have been occurring at work. Mobile devices differ from traditional IT in that they are mobile by nature and typically people carry them at all times. Thus mobile technologies enable the creation and organization of effective but flexible work environments (Kakihara and Sorensen 2002). Due to the mobile and communicational aspect, the mobile devices are more personal by nature, which leads the focus of value created to individual users. As Carlsson and Walden (2002) note, the key question for m-commerce is to find a way to evaluate the value that mobile applications have to offer for potential users. A significant advantage of mobile applications is that they allow the delivery of individualized/customized, relationship-based, timely and location-specific packets of information to a user (Mort and Drennan 2002). When being part of an organization, the value received by the individual user could transfer to the whole organization.

The methodology of this paper is a combination of literature review and conceptual analysis. By definition literature review means the selection of available documents on the topic written from a particular standpoint to fulfill certain aims or express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being proposed (Hart 1998). The use of conceptual analysis in this paper does not refer

to the strict use of conceptual analysis as a method, but rather that this is not purely a literature review but in addition a conceptualization and a new framework is provided based on the reviewed literature. The research objective is to create a preliminary research framework based on the literature review, for studying the potential business value created by B2B mobile services (B2B refers to business-to-business as opposed to business-to-consumer).

It is suggested in this paper, that the business value created by B2B mobile services can be realized on an individual level, or on organizational level, either directly or through the personal value. Depending on the type of the service, the value could be realized also only on an individual user's level or at the company level. The proposed framework is aimed at being used in a later phase of this research project. The research project concerning Business Value Created by B2B mobile services is aimed at developing a measurement tool for business value created by B2B mobile services.

The paper is organized as follows. In the second section B2B mobile services are defined and classified. In the third section business value of IT and different dimensions of it are presented. At the moment there is research concerning IT business value, but mobile business value is lacking research. In the fourth section, business value of B2B mobile services is discussed based on IT business value and a framework is proposed, followed by discussion and conclusion.

B2B mobile services

There seems to be a general agreement that mobile commerce (m-commerce) stands for the use of mobile (handheld) devices to communicate and conduct transactions through public and private networks (Balasubramanian et al. 2002). Mobile services can be defined as mobile commerce transaction messages and information services accessed by mobile devices (Mort and Drennan 2005).

There is a wide collection of mobile services that can be classified differently. Varshney and Vetter (2002) provide a classification of m-commerce applications based on the usage type. This contains ten classes, of which each is identified as business-to-consumer (B2C) or business-to-business (B2B) or both: mobile financial applications (B2C, B2B), mobile advertising (B2C), mobile inventory management/product locating (B2C, B2B), proactive service management (B2C, B2B), wireless re-engineering (B2C, B2B), mobile auction (B2C, B2B), mobile entertainment (B2C), mobile office (B2C), mobile distance education (B2C), and wireless data center (B2C, B2B). From this classification mobile office and mobile distance education that Varshney and Vetter (2002) identify only as B2C, could also be B2B. Mobile office services, bought from outside service providers, can be and are used within organizations (Juntumaa and Tuunainen 2006), and also mobile distance education could occur within an organizational setting. Thus, only

mobile entertainment and mobile advertising are now considered clearly B2C and left outside the analysis (Table 1).

Class of Application	Details	Examples
Mobile Financial Application	Mobile device as a financial medium	Banking and payments for mobile users
Mobile Inventory Management/ Product Locating	Applications aiming to reduce the needed inventory or locate needed products and services	Location tracking of goods, containers etc.
Proactive Service Management	Providing user information on services needed in near future	Transmission of information related to for example aging automobile components to dealers and vendors
Wireless Re-Engineering	Focus on improving the quality of business services using mobile devices and wireless infrastructure	Instant claim-payments by insurance companies
Mobile Auction	Allow users to buy or sell certain items using multicast support of wireless infrastructure	Airlines competing to buy a landing time slot during runaway congestion (a proposed solution to air-traffic congestion problem)
Mobile Office	Office environment to mobile users anywhere any time	Working from airport, conferences, customer's site etc.
Mobile Distance Education	Extending virtual education for mobile users	Taking a company training class via mobile streaming audio and video
Wireless Data Center	Making large amount of stored data available for mobile users to make "intelligent" decisions	Detailed information on one or more products could be downloaded by vendors on anytime/anywhere basis

Table 1. Classification of B2B Mobile Services (Adapted from Varshney and Vetter 2002)

The presented classification of B2B mobile services is quite extensive. On the other hand it is fragmented. As can be seen from the presented table (Table 1), it includes very different types of applications, such as, mobile auction, which is clearly an application for trading, and mobile office, which assists personal working and is not primarily aimed to be a tool for commerce but rather a B2B mobile service.

Mobility and personal characteristics of mobile services

The fact that B2B mobile services and applications differ from stationary IT/ICT services and applications makes it important to evaluate the value created by them separately. The difference can be seen mainly by two characteristics: mobility and personal use.

Mobility refers to the independence from time and place. By definition mobile services refer to delivery of service via mobile devices such as smartphones, mobile phones and personal digital assistants (PDAs) (Mort and Drennan 2002). This definition contains the assumption that due to the mobile devices, the service can be received regardless of the time or place. On the other hand May (2001) takes a more strict view to “mobile”. By his definition wireless is not a synonym to mobile, but being mobile, the primary usage environment is a mobile one. This makes sense in that there is no additional value for mobile phones if the phone call occurs in a situation where both (caller and receiver) are on a fixed location having a fixed telephone constantly by reach. Due to the very nature of mobile services, it is clear that they differ greatly from the more traditional desktop solutions that are fixed to a certain location and use is limited to the time when one is currently on that fixed location.

Personal use refers to that people tend to carry the devices with them at all times. Also messages and information people have on their mobile devices is typically more personal (for example SMS). As May (2001) noted, the mobile channel would be a bonded intimate part of people’s lives as opposed to separate fixed channels, mobile devices belong to people personally in a way that desktop devices will never achieve. The main function of a mobile phone is still to make voice calls, but the telecom industry has shifted focus from voice telephony to new services and advanced mobile phones that contain more and more additional services and applications. The B2B services in question are rather communicational and thus the purpose of use and personal aspect is different also in comparison to those mobile devices that are only used at work premises and left there after the shift is over (such as portable scanners in warehouses). Personal Information Management (PIM) applications (such as e-mail, calendar, and contacts on a mobile device) enable anytime and anywhere access to organization’s networks. By using mobile devices, employees can access real-time documents, discussions, and other information in corporate intranet. (Hayes and Kuchinskas 2003) Personal use and B2B context are thus not controversial, because these applications are used and carried personally, even though the basic idea is to use them for business purposes.

Business Value of IT

Business value seems to be a somewhat informal term having several definitions and slightly different contents. Melville et al. (2004) define IT Business value as *the organizational performance impacts of information technology at both the intermediate process level and the organization wide level, and comprising both efficiency impacts and competitive impacts* (p. 287).

The business value created by IT and measuring IT benefits in general is still an issue of concern and controversy as there have been different findings concerning the value added by the use of IT (e.g. Lin et al. 2005; Love et al. 2005; Davamanirajan et al. 2006). It is noted that measuring and controlling projects that involve investments would make more sense and be more simple if the measurement was done purely in terms of costs, but to realize the true value, applications and systems should be evaluated according to their business value for the firm (Davamanirajan et al. 2006). There is a lot of previous research on the impact of IT on firm performance. For example Zhuang and Lederer (2006) found that e-commerce can affect organization's performance for example through real-time and interactive exchange of information. Lin et al. (2005) found that the added value created by IT investments was perceived differently by participants in the organizations they studied, however the value was perceived through measures such as cost savings, competitive advantage, process efficiency, increased service level, and access to technical expertise. Strassmann (1990) categorizes the value added by IT to three value classes: *direct* (cost reduction, cost displacement, revenue growth), *indirect* (cost avoidance, performance improvement, risk reduction), and *inferred* (relationship redesign, competitive gain, competitive survival). The inferred benefits are the most difficult to evaluate or measure, since these benefits would typically occur only after several years and can not be measured in money as the direct benefits. Sugumaran and Arogyaswamy (2003) note that IT performance measures have lately advanced into more multidimensional constructs and the need to evaluate the overall performance and success have been recognized. They highlight the need to tailor performance measures to fit the type of IT in question.

Tallon et al. (2000) introduced a process-level model of IT business value. They define IT business value as the contribution of IT to firm performance and to assess this contribution they focus on how IT affects critical business activities within the value system of the company. The dimensions of IT business value they present follow Porter's (1985) presentation of the value chain. According to Porter's value chain model, each firm is a collection of activities aimed to design, produce, market, deliver and support its product(s). These are all value activities that are physically and technologically distinct activities that a firm performs. The value activities are divided into primary activities and support activities constituting the firms value chain. The level for constructing the value chain would

be the business unit (firm's activities in a particular industry). (Porter 1985) Based on this value chain model, Tallon et al. (2000) present six dimensions of IT Business Value, together with examples found from literature demonstrating how IT impacts these business activities. These dimensions are presented in Table 2.

Dimension of IT Business Value	Example
Process Planning and Support	IT can improve planning and decision making by improving organizational communication, coordination, and organizational flexibility
Supplier Relations	Coordination of supplier linkages and reduction of search costs
Production and Operations	Improvements in production process could lead to economies of scale in delivering products and services
Product and Service Enhancement	IT could help to develop new services and products and enable their differentiation
Sales and Marketing Support	Development of new services and products could help the organization to identify and serve new market segments
Customer Relations	Customer relations could be established, sustained and improved with IT, which can result in improved market share

Table 2. Dimensions of IT Business Value (Tallon et al. 2000)

Tallon et al. (2000) used these dimensions of IT Business Value as a basis for their assessment of impacts of IT on critical business activities within the value chain. They classified corporate goals for IT into four types: *unfocused*, *operations focus*, *market focus*, and *dual focus*. Unfocused goals means that IT is not viewed critical to any aspects of business strategy, thus goals for IT lack focus and direction. Operations focus refers to that current IT goals focus on cost reduction, improvement of quality and speed, and enhancing overall effectiveness. Market focus means that IT goals focus on extending market reach and changing industry and market practices. Finally, dual focus refers to that IT goals are a combination of both operations and market focus. These goals were found to be useful indicators of perceived IT payoffs: executives from companies having more focused goals were found to perceive greater IT value throughout the value chain.

Dedrick et al. (2003) note that the returns, or value of IT, should be examined at the disaggregate level of a firm and at the aggregate level of industry and economy, as the nature of the payoffs might be different at different levels. It is possible that some of the value is captured by an individual firm or the value might also flow to the customers creating social benefits and pass the firm; in any case it is possible that some value will show up at one level and not the other. (Dedrick et al. 2003) This suggestion could be extended to an assumption that some value might also show up to some divisions, or people within an organization and not the other. This is also supported, for example, by the empirical findings of a study

looking into benefits and barriers of Personal Information Managements applications: the benefits an organization can achieve from Personal Information Management application is gained through employees’ personal benefits from the use (Juntumaa and Tuunainen 2006).

Business Value of B2B mobile services

The evaluation of business value created by mobile services is even more challenging than evaluation of stationary, organizational IT, because of their personal and mobile nature. Dimensions of IT Business Value (Tallon et al. 2000) presented in Table 2, take clearly an organizational – or firm – perspective on the realized business value, which seems reasonable as it is based on Porter’s (1985) value chain of a firm, not individuals. However, the individual user level is missing, although most of the dimensions could be applied to the individual’s value from mobile applications, as well.

The following table (Table 3) presents which classes of B2B mobile applications, presented by Varshney and Vetter (2002), could create Business Value in each of the dimension of IT Business Value presented by Tallon et al. (2000). The table provides suggestions of the potential value realized in each value dimension by each mobile service. The realized business value created by the services and these suggestions will be tested on later phases of this research project.

Dimension of Business Value →	Process Planning and Support	Supplier Relations	Production and Operations	Product and Service Enhancement	Sales and Marketing Support	Customer Relations
Class of Application ↓						
Mobile Financial Application		X	X		X	X
Mobile Inventory Management/ Product Locating	X	X	X			X
Proactive Service Management	X	X	X	X	X	X
Wireless Re-Engineering	X	X		X		
Mobile Auction		X	X			
Mobile Office	X	X			X	X
Mobile Distance Education	X	X	X			
Wireless Data Center	X	X	X	X	X	X

Table 3. Dimensions of Mobile B2B Business Value (modified and combined from Tallon et al. 2000; Varshney and Vetter 2002)

In the first column (Table 3), process planning and support, mobility could improve planning and decision making, this could be achieved by improving communication, coordination and flexibility. At least there is already preliminary evidence that mobile office applications (e.g. Personal Information Management applications) can improve communication, coordination and flexibility (Juntumaa and Tuunainen 2006). In the second column, supplier relations, mobility could improve coordination of supplier linkages and reduce search costs. In a case study on mobile field work of sales persons, Rossi et al. (2007) found evidence of reduced billing cycle and increased visibility of inventory and invoicing. In production and operations, by improving these processes mobile applications could lead to economies of scale in delivering services. In the fourth column, product and service enhancement, mobile applications could help to develop new services and products, or enable their differentiation. Developing new services requires new ideas, which could be supported with, for example, a wireless data center or proactive service management that can deliver user information to those developing the services. Mobility could enhance sales and marketing by, for example, mobile financial applications. Finally in customer relations segment, mobile application could enable establishment of new customer relationships and sustain and improve existing ones. For example mobile office can improve communication also to the direction of customers, not only for internal communication.

The user benefits are clearly by nature increasing ease and convenience of users. Assistance, for example, in planning, communication and flexibility, could support everyday operations of users, who are typically working on non-repetitive and complicated tasks. Benefits for the organization as a whole would then be realized through users' operations. For example, increased efficiency and convenience concerning planning, communication and flexibility for users also ought to have positive impact on the organization as a whole. These benefits could result in such improvements as organization-wide time savings and better information flow.

The examples of the business value created by B2B mobile applications above also indicate that the value created at the level of individual user impacts business value on an organizational level. However, the value gained by users most typically culminate on an organizational level when there are enough individual users if the valuable use requires others to use the application too (network effects), such as instant messaging, as it does not increase the speed of communication unless the one the information is shared with, also uses the application. However, not all services or applications require large user base. For example, even if one key member of the organization uses the PIM applications, that might have large impact on an organizational level, via improved communication. Thus, there is preliminary evidence that the value created by mobile applications is realized on an individual user level and it could be viewed on an organizational level through

individual users (e.g. Juntumaa and Tuunainen 2006). The proposed model for B2B mobile services' business value realization can be seen from the Figure 1.

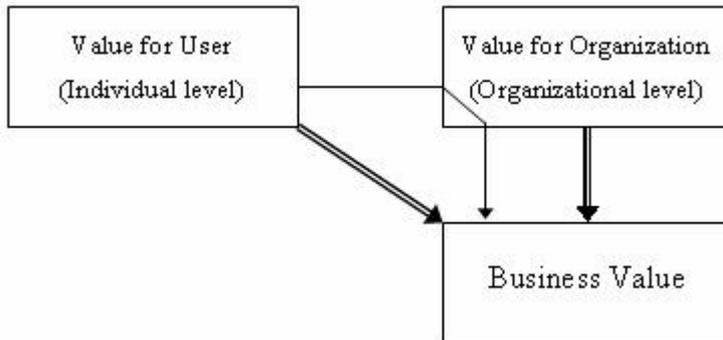


Figure 1. Proposed B2B Mobile Services' Business Value Realization

It is proposed, that the value could be realized either directly on an organizational or user level or value could be realized on an organizational level through individual users. The route from which the value is realized depends on the type of the service or application, and its usage. For example the use of mobile e-mail could be viewed as supporting employees' internal communication and thus creating value through improved work environment, or as an organizational means to improve communication with customers and thus creating value from improved customer and supplier service. However, the research concerning business value created by B2B mobile services should be started first on an individual user level. The usage of the services will then define from which route the actual value is realized.

Discussion and Future Research

Research concerning business value created by B2B mobile services is challenging since the value can not be seen directly in monetary terms, as is typical for any IT or ICT applications. Mobile services are more personal by nature than general IT applications that are used within an organization. Thus, the research concerning mobile applications should be started at a user level. There is already evidence from a preliminary study concerning Personal Information Management applications that the benefits on an organizational level are realized through the individual level (Juntumaa and Tuunainen 2006).

B2B mobile services and mobile applications in general, is a growing area for research. New mobile applications are constantly being introduced and launched and their use increases. Researchers have been paying attention to the need to measure the value created by IT, and also the potential business value created by

mobile applications needs to be measured. More extensive studies on both individual and organizational level are clearly needed to generate a more detailed understanding on how this value can be actually captured, and how the value is realized. The aim of this research project is to continue to develop a model to capture and measure Business Value created by B2B mobile services. Linking Business Value and individual user viewpoint is one of the key questions.

To be able to answer the question how the business value created by B2B mobile services can be measured and what the measurement system would be like, one first needs to consider what is the business value and which aspects are part of the business value concept. The discussed classification for IT business value dimensions (Tallon et al. 2000) could be adapted to B2B mobile services. Table 3 presented which types of B2B mobile services could add value in each business value dimension. One also needs to consider the unit of analysis for studying the created business value. The aim is to further develop the framework presented in this paper and to apply it to real business settings in order to collect quantitative empirical material from the business users' of mobile services.

Conclusions

B2B mobile services is a growing area in terms of both use and research. As organizations constantly invest in new technologies in order to gain some benefits, either for users or for the whole organization, the decision makers need to have some idea on which applications add value and which do not. Mobile services are intangible in nature and most typically provide rather indirect value. This makes it even harder to objectively evaluate the added value. Thus it is important for both practitioners as well as scholars to have a measurement tool for the created business value and also a more comprehensive view on potential business value. This on-going research project aims to fill into this gap.

This paper presented the starting point for a research project concerning business value created by B2B mobile services. The contribution of this paper was to open up the concept of business value of IT and B2B mobile services, followed by a conceptualization of potential business value created by B2B mobile services and how it could be realized.

References

- Balasubramanian, S., Peterson, R. A., and Jarvenpaa, S. L. (2002). "Exploring the Implications of M-Commerce for Markets and Marketing." *Journal of the Academy of Marketing Science*, vol. 30, no. 4, 348-361.
- Brynjolfsson, E., and Hitt, L. M. (1998). "Beyond the Productivity Paradox." *Communications of the ACM*, vol. 41, no. 8, 49-55.
- Byrd, T. A., Thrasher, E. H., Lang, T., and Davidson, N. W. (2006). "A Process-Oriented Perspective of IS Success: Examining the Impact of IS on Operational Cost." *Omega: the International Journal of Management Science*, vol. 34, no. 5, 448-460.
- Carlsson, C., and Walden, P. (2002). *Mobile Commerce: A Summary of Quests for Value-Added Products and Services*. 15th Bled Electronic Commerce Conference, Bled, Slovenia.
- Davamanirajan, P., Kauffman, R. J., Kriebel, C. H. and Mukhopadhyay, T. (2006). "Systems Design, Process Performance, and Economic Outcomes in International Banking." *Journal of Management Information Systems*, vol. 23, no. 2, 65-90.
- Dedrick, J., Gurbaxani, V., and Kraemer, K. (2003). "Information Technology and Economic Performance: A Critical Review of the Empirical Evidence." *ACM Computing Surveys*, vol. 35, no. 1, 1-28.
- Gefen, D., and Ragowsky, A. (2005). "A Multi-Level Approach to Measuring the Benefits of an ERP System in Manufacturing Firms." *Information Systems Management*, vol. 22, no. 1, 18-25.
- Hart, C. (1998). *Doing a Literature Review. Releasing the Social Science Research Imagination*. London, SAGE Publications.
- Hayes, K., and Kuchinskas, S. (2003). *Going Mobile. Building the Real-Time Enterprise with Mobile Applications that Work*. San Francisco, CMP Media LLC.
- Juntumaa, M., and Tuunainen, V. K. (2006). *PIM Applications - An Explorative Study on Benefits and Barriers*. 19th Bled eConference, eValues. Bled, Slovenia.
- Kakihara, M., and Sorensen, C. (2002). *Mobility: An Extended Perspective*. Hawaii International Conference on System Sciences (HICSS-35), Waikoloa, Big Island Hawaii
- Leung, K., and Antypas, J. (2001). "Improving Returns on M-Commerce Investments." *Journal of Business Strategy*, Sep/Oct, 12-13.
- Lin, C., Pervan, G., and McDermid, D. (2005). "IS/IT Investment Evaluation and Benefits Realization Issues in Australia." *Journal of Research and Practice in Information Technology*, vol. 37, no. 3, 235-251.
- Love, P. E. D., Irani, Z., Standing, C., Lin, C., and Burn, J. M. (2005). "The Enigma of Evaluation: Benefits, Costs and Risks of IT in Australian Small-Medium -Sized Enterprises." *Information & Management*, vol. 42, no. 7, 947-964.
- May, P. (2001). *Mobile Commerce. Opportunities, Applications, and Technologies of Wireless Business*. Cambridge, Cambridge University Press.
- Melville, N., Kraemer, K., and Gurbaxani, V. (2004). "Review: Information Technology and Organizational Performance: an Integrative Model of IT Business Value." *MIS Quarterly*, vol. 28, no. 2, 283-322.
- Mort, G. S., and Drennan J. (2002). "Mobile Digital Technology: Emerging Issues for Marketing." *Journal of Database Marketing*, vol. 10, no.1, 9-23.
- Mort, G. S., and Drennan, J. (2005). "Marketing M-Services: Establishing a Usage Benefit Typology Related to Mobile User Characteristics." *Database Marketing & Customer Strategy Management*, vol 12, no. 4, 327-341.
- Porter, M. E. (1985). *Competitive Advantage. Creating and Sustaining Superior Performance*. New York, Free Press.

- Rossi, M., Tuunainen, V. K., and Pesonen, M. (2007). "Mobile Technology in Field Customer Service - Big Improvements with Small Changes." *Business Process Management Journal*, vol. 13, no. 6, (forthcoming).
- Strassmann, P. A. (1990). *The Business Value of Computers*. New Canaan, Connecticut, The Information Economics Press.
- Sugumaran, V., and Arogyaswamy, B. (2003). "Measuring IT Performance: "Contingency" Variables and Value Modes." *Journal of Computer Information Systems*, vol. 44, no. 2, 79-86.
- Tallon, P. P., Kraemer, K. L., and Gurbaxani, V. (2000). "Executives' Perceptions of the Business Value of Information Technology: A Process-Oriented Approach." *Journal of Management Information Systems*, vol. 16, no. 4, 145-173.
- Tarasewich, P., Nickerson, R. C., and Warkentin, M. (2002). "Issues in Mobile E-Commerce." *Communications of the Association for Information Systems*, vol. 8, 41-64.
- Varshney, U. and Vetter, R. (2002). "Mobile Commerce: Framework, Applications and Networking Support." *Mobile Networks and Applications*, vol. 7, no. 3, 185-198.
- Zhuang, Y., and Lederer, A. L. (2006). "A Resource-Based View of Electronic Commerce." *Information & Management*, vol. 43, no. 2, 251-261.

How Can Companies Work with Open Source Communities for Open Innovation?

Mikko Ahonen¹, Maria Antikainen², Marko Mäkipää¹

University of Tampere¹, VTT ²Affiliation(s)

mikko.ahonen@uta.fi, maria.antikainen@vtt.fi, marko.makipaa@uta.fi

Abstract. Innovation activity in companies is more and more focused on integrating internal research with external development groups. However, researchers and practitioners have had difficulties in explaining the value creation methods of the Open Innovation paradigm using analogy of open source initiatives. Similarly, companies often approach open source with insufficient level of knowledge, which may cause problems. In this paper we examine how a company can integrate itself systematically to open source communities and utilize viable and sustainable business model for commercial exploitation. Case examples are provided from open source software context to illustrate the mechanisms of utilizing external research and development resources and how open source is integrated into a business. As a result, we present models and lessons learned from building open source communities to facilitate innovation activity.

Keywords: open source, open innovation, community, toolkit, trust

Introduction

Successful technological innovation in firms is strongly dependent upon managing sufficient knowledge resources to support continuous discovery, knowledge creation and technical development. Often, a strategy and a process are needed to collaborate with external groups and networks. Open Innovation paradigm (Chesbrough, 2003) stresses the importance of using a broad range of sources for a firm's innovation and invention activities, including customers, rivals, academics, and firms in unrelated industries while simultaneously using different methods to protect firm's Intellectual Property (IP). Open Innovation needs also open business models and therefore Open Innovation researchers (e.g. West and Gallagher (2006), Chesbrough (2006) and West (2007) have had interest in open source.

However, within the Open Innovation literature there are not many descriptions, how the co-operation with innovation communities takes place, especially when users are innovating by themselves. In the literature there are some descriptions like the one from von Hippel (2005) who explains the nature of these communities:

Innovation communities can have users and/or manufacturers as members and contributors. They can flourish when at least some innovate and voluntarily reveal their innovations, and when others find the information revealed to be of interest. ... these conditions do commonly exist with respect to user-developed innovations: users innovate in many fields, users often freely reveal, and the information revealed is often used by manufacturers to create commercial products—a clear indication many users, too, find this information of interest. (von Hippel, 93, 2005)

Open source software (OSS) communities are good examples of these innovation communities, where free revealing is an important element. However, the view of von Hippel (2005) stretches to wider areas than software, like hardware and service development.

In this paper we inspect how a company can integrate itself systematically to open source communities. First we will discuss about the open source 2.0 phenomenon and then we will make distinctions between Open Innovation and open source. Information systems research topics are viewed through innovation communities and their use of toolkits. The research question here is: *How should a company work with open source communities to support its innovation strategy.* Since we do not have comprehensive data available from companies, we base our findings in the literature and present some models (Grand *et al.* 2004, West and Gallagher 2006) which explain innovation activity within innovation communities.

Open source 2.0, communities and companies

Much of OSS research has focused inward on the phenomenon itself, studying the motivations of individual developers to contribute to OSS projects, or investigating the characteristics of specific OSS products and projects, for example. Far less has been done in looking outward at the process of OSS adoption and implementation in organizations. (Fitzgerald, 2006, 588)

In order to work with open source communities, companies need to learn what open source (software) is. Therefore, the first step is to use OSS within the company and learn lessons about its adoption and usage. Only thereafter the company is fully capable of integrating itself and its employees to open source communities. The first generation of OSS was about enthusiastic amateurs while the second generation of OSS is about companies working closely and integrating themselves to open source communities. Fitzgerald (2006) uses the OSS 2.0 term meaning that open source software phenomenon has metamorphosed into a more mainstream and commercially viable form.

In order to explore the firm-level implications of OSS, it is important to put OSS innovation in a broader context of models of technological innovation.

Innovation strategy can be divided into two basic choices. First, private innovation assumes that returns to the firm result from private goods and efficient regimes of intellectual property protection taking place within firm boundaries or as part of a firm's web of partnerships. Second, collective innovation assumes that firms collaborate with public institutions such as universities to produce a public good, where public access to the results and transparent communication of the research and development process are inherent (Grand *et al.* 2004).

Another division is provided by von Hippel and von Krogh (2003). Their model is called the private-collective model. In this model economic actors invest their private resources to produce a public good. Open source software development is an exemplar of a compound "private-collective" model of innovation that contains elements of both the private investment and the collective action models and can offer society the "best of both worlds" under many conditions. (von Hippel and von Krogh (2003, 209).

Distinction between private and collective innovation is useful, but Private-Public division to represent them is inadequate. In case of OSS, collective innovation is many times a result of group of individuals without any intervention of private or public organizations. In OSS context community innovation is better metaphor than collective-public innovation. However, in OSS 2.0 this division is not anymore this simple as mixed forms are emerging and developed.

West (2007) describes two different types of communities organized around a particular shared product (open source software): those sponsored by an (usually corporate) organization, and the more traditionally studied autonomous communities.

According to West (2007) one of the characteristics of sponsored communities is that they are different in that they face conflicting goals between those of the sponsor and those of the community. The sponsor would like to control the community, but creates the community in hopes of attracting participation and growth. At a minimum, the sponsor must provide transparency. In most cases, the sponsor retains privileged (monolithic) rights for some portion of the community's decisions. In some cases, the sponsor shares control with the community and in rare cases, bestows upon the community full autonomy.

Furthermore, communities sponsored by government or non-profit actors are more likely to favor public good ahead of the sponsor's pecuniary gain, but face the same tension between maintaining control and attracting community participation and growth (West, 26, 2008). For private companies these challenges are even more difficult to manage, if they seek to transform the results to profitable business. Company can lose its face and trustworthiness very quickly if it acts against the community's expectations. Legal rights can be very different from moral rights when participating in or sponsoring open source communities.

Open Innovation versus open source

The OSS phenomenon has intrigued a lot of interest and enthusiasm to extend the ideology also to other areas than software. Open Innovation term has been coined by Henry Chesbrough (2003) and originally has described the changes in business models and innovation processes of large companies. In other words, the origins of Open Innovation and OSS are originally far away from each other.

The Open Innovation paradigm is often contrasted to the traditional vertical integrations where internal R & D activities lead to internally developed products that are then distributed by the firm. West & Gallagher (2006) therefore define Open Innovation as:

“systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels”

Piller et al. (2004) see certain limitations in Open Innovation. Therefore, they suggest a new approach:

“...Open Innovation in our understanding goes one important step further: Open innovation aims at transferring the ideas and approaches from open source software development to the domain of other product categories and services. The idea is to build and operate platforms where (communities of) customers and users create, develop, and discuss newly customized products and services.” (Piller *et al.*, 2004, 5)

Similarly, von Hippel (2005) discusses about toolkits in the innovation activity of a company.

Firms that understand the distributed innovation process and users' roles in it can change factors affecting lead user innovation and so affect its rate and direction in ways they value. Toolkits for user innovation custom design offer one way of doing this. ...The resulting co-location of sticky information and problem-solving activity makes innovation within the solution space offered by a particular toolkit cheaper for users. It accordingly attracts them to the toolkit and so influences what they develop and how they develop it. (von Hippel, 16, 2005)

These toolkits are in essence information systems and software tools. Toolkits and communities around them are described by Piller *et al.* (2004) and Ahonen *et al.* (2007). *In line with the open source concept, but as an extending feature to the toolkit approach, the presented solution is embedded in an online community. Thus, contributions by innovative users can be stored in a library leading to a continuously growing information pool of available components.* (Piller *et al.*, 2004).

So, the actual toolkits can be free, even developed in open source communities but the communities and web-based services can be commercial.

How does Open Innovation paradigm (Chesbrough 2003, Chesbrough *et al.* 2006) then integrate with open source development methodologies and the activities in communities? According to Chesbrough (2006):

“Open Innovation is sometimes conflated with open source methodologies for software development. There are some concepts that are shared between the two, such as the idea of greater external sources of information to create value. However, Open Innovation explicitly incorporates the business model as the source of both value creation and value capture. This latter role of the business model enables the organization to sustain its position in the industry value chain over time. While open source shares the focus on value creation throughout an industry value chain, its proponents usually deny or downplay the importance of value capture.” (Chesbrough, 2006, 2)

Similarly, West and Gallagher (2006) list various open source projects and see that for example Project GNU and Mozilla projects are not Open Innovation because their business model is missing. From the point of view of OSS 2.0, however, Mozilla can be seen Open Innovation because employees of companies like IBM work in the Mozilla community to provide the Firefox browser that supports IBM's products and may even be more functional than the competitor's (Microsoft's) browser. According to West and Gallagher (2006) IBM's Eclipse (<http://www.eclipse.org>) is both Open Innovation and open source since IBM still has hundreds of developers committed to Eclipse projects although it Eclipse is nowadays governed by an OSS foundation. Thus, the OSS 2.0 provides many mixed and sometimes even very complex commercial opportunities for companies,

similar to Open Innovation. The complexity of OSS 2.0 and Open Innovation business models introduce new management challenges which differ from those of proprietary innovation models. West and Gallagher (2006) emphasise three management factors, namely motivating, incorporating and maximising.

Innovation Model	Management Challenges	Resulting Management Techniques
Proprietary (or internal or “closed”)	<ol style="list-style-type: none"> 1. Attracting “best & brightest” 2. Moving research results to development 	<ol style="list-style-type: none"> 1. Provide excellent compensation, resources, and freedom. 2. Provide dedicated development functions to exploit research and link it to market knowledge
External	<ol style="list-style-type: none"> 1. Exploring wide range of sources for innovation. 2. Integrate external knowledge with firm resources & capabilities 	<ol style="list-style-type: none"> 1. Careful environmental scanning 2. Developing absorptive capacity, and/or alliances, networks, and related consortia
Open	<ol style="list-style-type: none"> 1. Motivating the generation & contribution of external knowledge 2. Incorporating external sources with firm resources & capabilities 3. Maximising the exploitation of diverse IP 	<ol style="list-style-type: none"> 1. Provide intrinsic rewards (e.g. recognition) and structure (instrumentality) for contributions. 2. As above 3. Share or give away IP to maximise returns form entire innovation portfolio.

Table 1. Models of innovation and resulting managerial issues (West & Gallagher, 2006)

Open Innovation model through motivating, incorporating and maximising means constant communication between a company and a community. Next a closer look is taken at this integrative activity.

Costs and benefits of integrating to OSS 2.0 community

Grand *et al.* (2004) have suggested a four level model of resource allocation for firms ranging from a modest investment in developing knowledge about OS to a compatible business model. According to this model:

Level	Description
1	OS software is used in order to replace or supplement existing software within the firm, without implications for the user-firm's business model. Any firm in any technological or industrial context can become involved in OS innovation as a user of the software - however, the fact that substantial expertise may be needed to run OS code within existing IT infrastructures is partly responsible for the emergence of business approaches for specialized software/IT firms at the other three levels.
2	OS software is used as a complementary asset, which is combined with other software or hardware to deliver integrated solutions for level 1 OS users. The firm integrating OS software as complementary asset must invest substantial development resources to adapt the code to its particular services and turning it into a stable technological solution. In addition, the software thus developed must be publicly released, according to the licensing agreement of the OS software used.
3	OS software is not only seen as a complementary asset, but as core for the entire software developed by the specialized firm. At this level, companies both complement their own software with OS 'building blocks', but essentially build their own software based on the freely available code. As, in either case, the entire developed code must be freely released back to the OS community, this clearly implies a substantial commitment a firms' own business model to OS.
4	The packaging, bundling and distribution of stable services and solutions for OS software becomes the business model itself, complementing the interests of the many level 1 firms. The emergence of Level 4 firms can be seen as the natural outcome of the success of the OS software community.

Table 2. Four-level management model of increasing private resource allocation (Grand et al., 2004)

Like mentioned in the table above, the fourth phase of Grand *et al.* (2004) means that activities within the OS community becomes a business model itself.

Grand *et al.* (2004) have also analysed costs and benefits of firm involvement in OS innovation. Both the risks and benefits increase towards the higher levels of the model. In their study they emphasize the importance of knowledge in firms to be able to make the decisions how to integrate OSS in their innovation process.

Business models, open source and Open Innovation

Open source offers one possibility for companies that are continuously seeking new opportunities to organize their business activities and to increase the amount of value they produce. Furthermore, the concept of a business model is considered as a tool for exploring new business ideas and capturing the essential elements of each alternative. Within Open Innovation literature the term open business model is used (Chesbrough, 2003, 2006).

A business model performs two important functions: it creates value, and it captures a portion of that value. It creates value by defining a series of activities from raw materials through to the final consumer that will yield a new product or service with value being added throughout the various activities. The business model captures value by establishing a unique resource, asset, or position within that series of activities, where the firm enjoys a competitive advantage. An open business model uses this new division of innovation labor – both in the creation of value and in the capture of a portion of that value. Open models create value by leveraging many more ideas, due to their inclusion of a variety of external concepts. (Chesbrough, 2006, 2)

What are those elements of business models? An important consideration is the context-specificity of a business model. Is there a need for specific models that are targeted to a particular industry and particular product/service combinations? Regardless of the several industry-related papers devoted to these (such as business models for e-business – referring to Rappa, 2007; Rayport & Jaworski, 2001; Weill & Vitale, 2001), Seppänen *et al.* (2007) propose that all business models share common elements. A generic business model should involve the same elements regardless of the industry where the model is used. Then, a context-specific model – perhaps with a prefix – should be seen as a local application of a general business model. (Seppänen *et al.*, 2007). Since the question of relationships and partner networks are essential in business models, communities and their building will be next inspected.

Building communities

Fogel (2005) has pointed out difficulties in establishing an Open source project:

One of the most common mistakes is unrealistic expectations about the benefits of open source itself. An open license does not guarantee that hordes of active developers will suddenly volunteer their time to your project, nor does open-sourcing a troubled project automatically cure its ills. In fact, quite the opposite: opening up a project can add whole new sets of complexities, and cost *more* in the short term than simply keeping it in-house.

Opening up means arranging the code to be comprehensible to complete strangers, setting up a development web site and email lists, and often writing documentation for the first time. All this is a lot of work. (Fogel, 2005, 51)

Fogel continues:

The hardest part about launching a free software project is transforming a private vision into a public one. You or your organization may know perfectly well what you want, but expressing that goal comprehensibly to the world is a fair amount of work. It is essential, however, that you take the time to do it. You and the other founders must decide what the project is really about—that is, decide its limitations, what it *won't* do as well as what it will—and write up a mission statement. This part is usually not too hard, though it can sometimes reveal unspoken assumptions and even disagreements about the nature of the project, which is fine: better to resolve those now than later. The next step is to package up the project for public consumption, and this is, basically, pure drudgery. (Fogel, 2005, 52)

If people feel that they are involved in the decision-making process and that their viewpoints are heard and respected, then the community will generally accept whatever decision is made. If people feel that a decision is made without hearing their opinions, then they will object and, in the worst case, go elsewhere, possibly forking the source code and starting a competing project.

The exact decision-making process varies from one open-source project to the next, but in many it is based on the idea of a meritocracy: Those who have demonstrated their competency through their work on the project are the ones who make the decisions. In many cases, the project lead, often the originator of the code, has the final say. Likewise, module owners make decisions that affect their module. This works only as long as the "benevolent dictator" can maintain the respect of the developer community; otherwise, the community will call for a replacement. (Goldman and Gabriel, 2005)

Conclusions

Previously very company centric innovation process has experienced many changes during the last decades. Globalization and developments in information and communication technologies have enabled companies to distribute R&D processes globally both inside the firm boundaries and outside. Outsourcing and strategic alliances have attained a sustainable position in management strategies. Today, the Open Innovation paradigm is challenging companies' innovation strategies provoked by success of open source software communities.

OSS offers a fascinating model for future innovation and knowledge creation and brand new challenges for companies. Previously companies have concentrated on value creation and have received income from that activity. In network economy, based on core competencies and outsourcing, the absorptive capacity has been raised to be in a key position in firms' innovation strategies. In an emerging business environment building on open innovation and OSS 2.0 like business models companies no longer are the sole creators of value, but instead find themselves from the centre of complex network of value creators; both individual and organizational, both private and public. In this kind of environment only those companies that learn new value harnessing activities and are able to optimize their value creation/harnessing activities for total offering portfolio will survive. Companies need to start building their networks and communities and persuade others to join in and contribute.

Discussion

Most of our examples and references describe open source software development. However, models from OSS are more and more applied to services and hardware development. Both OSS 2.0 and Open innovation may offer remarkable benefits for companies, yet they include many challenges.

If the company succeeds in integrating itself to OSS 2.0 communities, it does not automatically provide help with its innovation activities. According to West and Gallagher (2006, 29) when open source software is used as part of a complex system, a firm still faces the fundamental issues of coordinating the systemic innovation, assuring overall value creation and capturing the firm's portion of that value. While open source has been celebrated as a new and different approach to software development, its emergence ironically has coincided with the emergence of stronger intellectual property protection for patents and other IP (Chesbrough, 2006, 48) For this reason Chesbrough recommends that companies should consider *both* advancing towards open source *and* simultaneously heading towards stronger IP protection. Companies also face certain risks while embracing open source as part of their business models: the OSS community's contribution may not remain active forever and when OSS becomes mainstream there is always risk for Intellectual Property Rights (IPR) infringement (Fitzgerald, 2006).

Therefore, much more research is still needed to better understand the emerging role that OSS 2.0 and Open Innovation will have in companies' innovation strategies and practices. This study will continue by participating a project from Autumn 2007 till Spring 2009 where companies systematically integrate into OSS communities and use open source software as part of their industrial, hardware products. This opportunity allows us to continue developing the body of knowledge of OSS 2.0 and Open Innovation by collecting empirical data from real company-OSS community collaboration.

References

- Ahonen, M., Antikainen, M., & Mäkipää, M. (2007). *Supporting Collective Creativity within Open Innovation*. European Academy of Management Conference. Conference proceedings. EURAM: Paris.
- Antikainen, M. and Aaltonen, T. (2007). In Helander, N. & Antikainen, M. (eds.), *Essays on OSS practices and sustainability*. e-Business Research Center Research Reports 36. Tampere University of Technology & University of Technology
- Antikainen, M. and Aaltonen, T. (2007, forthcoming). *The role of trust in OSS communities – Case Linux Kernel community*. Accepted for publication in The Third International Conference of Open Source Systems, Limerick, June 13-16, 2007.
- Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.
- Chesbrough, H.W. (2006). *Open Business Models How to Thrive in the New Innovation Landscape*. Boston (Mass.): Harvard Business School Press.
- Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open Innovation: Researching a New Paradigm*. Oxford: Oxford University Press.
- Fogel, K. (2005). *Producing Open Source Software: How to Run a Successful Free Software Project*. Sebastopol, CA: O'Reilly.
- Gallivan, M. (2001). Striking a balance between trust and control in virtual organizations. *Info Systems*, 11, 277-304.
- Goldman, R., & Gabriel, R.P. (2005). *Innovation Happens Elsewhere: Open Source as Business Strategy*. Morgan Kaufmann.
- Grand, S., von Krogh, G., Leonard, D. & Walter Swap. (2004) Resource Allocation Beyond Firm Boundaries: A Multi-Level Model for Open Source Innovation. *Long Range Planning* 37, 591-610.
- Hertel, G., Niedner, S. and Herrman, S. (2003). Motivation of software developers in open source projects: An Internet-based survey of contributors to the Linux Kernel. In J. Feller, B. Fitzgerald, S. Hissam and K. Lakhani (eds.), Taking stock of the bazaar. *Proceedings of the 3rd Workshop on Open Source Software*.
- von Hippel, E.V. (2005). *Democratizing Innovation*. Cambridge, MA: MIT Press.
- von Hippel, E.V., & von Krogh, G. (2003). Open Source Software and the "Private-Collective" Innovation Model: Issues for Organization Science. *Organization Science*, 14(2), 209-223.
- Luhmann, N. (1979). *Trust and power*. New York: J. Wiley.

- O'Leary, M., Orlikowski, W. and Yates, J. (2001). Distributed work over the centuries: trust and control in the Hudson's Bay Company (1670-1826). In P. Hinds and S. Kiesler (eds.), *Distributed work*. Cambridge: MIT Press.
- Osterloh, M., & Rota, S. (2007). Open source software development--Just another case of collective invention? *Research Policy*, 36(2), 157-171.
- Rappa, P. (2007) Business Models on the Web. <http://digitalenterprise.org/models/models.html>. Last accessed: 10th June, 2007.
- Rayport, J. and Jaworski, B. (2001). *Electronic Commerce*. New York: McGraw-Hill.
- Rotter, J.B. (1971). Generalised expectancy for interpersonal trust. *American Psychologist*, Vol. 26 pp.443-52.
- Seppänen, M., Helander, N. and Mäkinen, S. (2007) Business models in open source software value creation. *Open source software Handbook*.
- Timmers, P. (2003). Lessons from E-Business Models. *Zeitschrift für Betriebswirtschaft. ZfB – Die Zukunft des Electronic Business* (1): 121-140.
- Weill, P. and Vitale, M. (2001). *Place to Space: migrating to ebusiness models*. Boston: Harvard Business School Press.
- West, J. (2007). Sponsored open source communities. *Managing Open Innovation through Online Communities*.
- West, J. & Gallagher, S. (2006). Patterns of Open Innovation in Open Source Software . In Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.) *Open Innovation: Researching a New Paradigm*. 82-106. Oxford University Press: Oxford, UK.

eCollaboration and Impact on Task and Task Output: Ten case studies

Anita Mirjamdotter

Luleå University of Technology, Social Informatics/Dept. of Business Administration and Social Sciences, Sweden

Anita.Mirijamdotter@ltu.se

Katarina Stanoevska-Slabeva

University of St. Gallen, Institute for Media and Communication Management, Switzerland

Katarina.Stanoevska@unisg.ch

Abstract.

At present several developments drive changes in the way how work is organized in organizations. The major trends that impact work are the prevailing digitalization of processes and assets in organizations due to use of information and communication technology (ICT), open innovation, mobile work, and globalization. This paper examines eCollaboration in various settings with the aim of exploring impact on innovation, creativity, and productivity. In total ten cases are included. Basic definitions, on which the research framework is based, are given and preliminary results of the cases are discussed. These relate to organisational patterns and new working structures, use of collaboration technology, and e-Collaboration's impact on creativity, innovation and productivity.

Keywords. eCollaboration, teams, diversity, creativity, productivity, innovation, collaboration technologies

1. Introduction

The increased application of ICT in organizations has imposed several changes in work practices. Since the 1980s there is a clear trend away from strict hierarchies to new working practices based on teams and empowerment of employees with access to knowledge and responsibilities (Mohrman, Cohnen & Mohrman, 1995). Several case studies related to virtual teams' application of collaborative technology show a clear shift to lower hierarchies in teams due to use of technology (May & Carter, 2001; Majchrzak et al., 2000). Similar effects can be observed also with respect to e-mail and other technologies (Groth, 1999). Resulting from the ability of ICT to reduce

transaction costs, there is furthermore a clear trend towards dis-aggregation of companies and re-aggregation towards networks. In the era of global connectivity and networked economy, organizations are transforming towards networked organizations (Easton 1992; Hamel & Prahalad, 1994; Gulati et al., 2000; Alt & Oesterle, 2004) with complex relationships to suppliers, customers and other stakeholders (Jarvenpaa & Blake, 1994). Open innovation is for example one new approach to involve external stakeholders of companies, in particular customers, in collaborative innovation processes (Chesbrough, 2003). Other trends that drive changes in work practices are the increasing importance of mobile work and the maturing ICT support for mobile workers (for an overview see Andriessen & Vartiainen, 2006, and the specific country reports in Collaboration@Work, 2006).

As a consequence of the above developments, there is a clear shift towards eCollaboration within companies and mobile teams that deal with new business processes. Teams of that kind can be observed with respect to more routine and structured processes, as production teams, but also with respect to knowledge based tasks, such as marketing and R&D. Particularly in R&D multi-disciplinary and inter-cultural teams are expected to improve company innovation and creativity by access to knowledge and competences in different parts of the world. Due to Europe's enlargement, European companies are confronted with and have the possibility to take advantage of increased cultural diversity in Europe. However, in order to take advantage of such new working practices new concepts for organizing work including innovative collaboration technology are required. Currently there is a gap in research and practice related to these phenomena. Such concepts are being developed and piloted by international players – however, it is still early days and there is no “dominant design” or best practice available that broadly could be applied.

The aim of this study is to contribute in this area by analysing cases of emerging eCollaboration and new working structures, and by assessing their impact on productivity, innovation and creativity in companies. In the following some basic definitions are given on which we base our research framework, followed by the methodology employed and summary of cases. The paper ends by discussing findings so far, conclusions and further research.

2. Research Framework and Basic Definitions

To achieve the aim of the study it is important to find out about components of eCollaboration, their interrelationships and their impact on the collective performance in terms of productivity, innovation and creativity. In the following some central concepts are defined and discussed. These relate to the research framework, see Figure 1, on which we base our study.

2.1. eCollaboration

eCollaboration is defined slightly different by different authors. Gartner (2006), for example, states that “Collaboration is about people working together.”, while Alt (2003) provides an overview of definitions that are indifferent whether the parties who work together are people, groups or organisations or even machines. In this study the focus lies on eCollaboration based on human participation. Given this

eCollaboration is defined in accordance to Kock & Nosek (2006), as “...collaboration among individuals engaged in a common task using electronic technologies.”

According to Kock (2005) there are five conceptual elements of eCollaboration:

- The collaborative task, whose nature (simple or complex) can have a strong effect on the outcome of eCollaboration and the appropriate collaboration technology for the specific task.
- The eCollaboration technology, whose features and offered services may have a strong impact on how the technology is used and may require business process redesign and alignment of organizational structures.
- The individuals involved in the collaborative task. Their characteristics have an impact on how collaboration is performed, how collaboration technology is used, and how individuals behave. In particular the diversity of involved individuals impacts the success and outcome of collaboration. The individuals are usually organized in different, more or less structured, organizational collaboration settings.
- The physical environment surrounding the individuals; it comprises the actual tangible items that are part of the environment surrounding the individuals involved in collaborative tasks, as well as the geographical distribution of the individuals.
- The social environment surrounding the individuals; this might have social influences on the individuals involved in collaboration.

While the first three concepts can be clearly separated, the last two concepts can be considered as part of the task and team structure involved in the collaboration. The above concepts provide a foundation for the first version of the conceptual research framework of this study, in that it provides an overview of eCollaboration concepts and their interrelationship, see Figure 1.

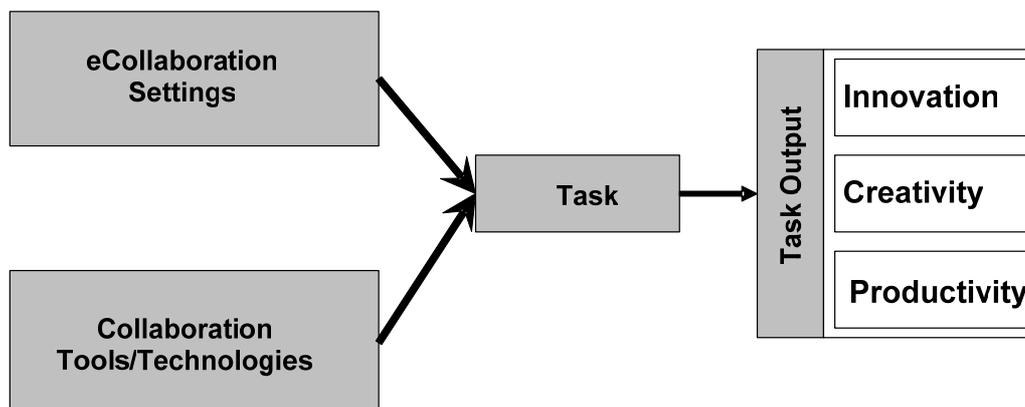


Figure 1. Main components of eCollaboration and inter-relationship

The box eCollaboration Settings, see figure 1, is addressed with a focus on organisational patterns and diversity of teams next in this section. The arrows to Task illustrate that various organisational settings and various tools and technologies are more or less apt for the tasks that are involved in eCollaboration. Finally, the objective of a task in terms of its output is considered in relation to the aim of this study, i.e., eCollaboration, new working structures and impact on innovation, creativity and productivity in companies.

2.2. Organisational Patterns and Diversity of eCollaboration Settings

Collaboration implies the involvement of at least two persons. The involved individuals can be organized in different ways. In addition, they have different individual features that result in a diversity of collaboration settings. For the purpose of this study we will understand any type of existing or emerging organizational settings that involve individuals engaged in a common task using electronic technologies as eCollaboration or collaboration setting. Collaboration can take place in different more or less structured and formalized groupings in organizations, such as teams, virtual teams, groups, squads, task forces, quality circles, and networks (Holst, 2007; Manguin, 2004). It is, though, expected that one of the prevailing form of eCollaboration settings are virtual teams.

In literature there are many different definitions about teams. The broadest definitions characterize teams as “people doing something together” (Robbins & Finley, 1995). Other definitions aim to define teams in a more concrete way by describing distinguishing features of teams (e.g. Harris & Harris 1996; Katzenbach & Smith, 1993; Manguin, 2004). In summary, teams that will be the subjects of this research are defined as follows: A group of people that have a commitment to a set of shared values and objectives, together with an acceptance of how those objectives are to be met. Main team features are: defined number of people involved; a common goal; complementary skills; a common approach; cooperation and coordination; and commitment to teamwork.

A special category of teams are virtual teams. The possibility to build virtual teams, i.e. to have tasks accomplished by groups, which never or rarely meet face-to-face, is enabled by Information and Communication Technologies (Lipnack & Stamps, 2000) like the Internet, mobile phones and collaborative tools. Virtual teams can not only be separated geographically but also organizationally (i.e., members that accomplish a common task are employed in different organizations) or by time (i.e., members work in different time zones). Thus, we define virtual teams as team that consists of geographically or organisationally dispersed workers brought together to accomplish a specific organisational task using ICT.

As described above teams as an organisational structure are clearly delimited. In contrast to teams, communities in different forms (e.g., communities of practice or open innovation communities) are less structured and delimited in collaborating settings. In communities of practice communication and relationship building and sustaining processes evolve (Lave & Wenger, 1991). It is argued that these provide an environment in which members share, construct, and learn together (Kling & Hara, 2002). As for many other concepts, there is no generally accepted definition of online communities and we see a resemblance to the concept of communities of practice. The term online communities is used in accordance with Schoberth, Preece & Henzl (2003) to describe the communication and social interaction that can be observed around different kind of communication tools, e.g., blogs, chats, bulleting boards, and similar.

Besides the specific structure of the collaboration setting, also its size, i.e. the number of involved individuals, has an impact of the performance of the collaboration and the efficient use of collaboration technology (DeSanctis & Gallupe, 1987; Holst & Mirijamdotter, 2006). Each individual participant in collaborative work is characterised by specific features, which distinguish him/her from other participants in the collaboration. Taken together the differences among collaborating individuals define the diversity of the collaborating team.

Main diversity aspects are: age, gender, disciplines and qualification, functional belonging, geographical distance, and culture. The first five diversity aspects are basically self explaining, while culture is a term that has diverse meaning.

There is no common definition for the term “culture”; each person has an idea about what culture is and there are many different definitions for this term. Elashmawi and Harris (1993) suggest that culture is based on agreed behavioural norms, specific to a certain group of people at a certain time and place which are needed to coexist. In Gudykunst’s words (1994): “culture is our theory of the ‘game being played’ in our society”. Common elements in culture definitions are influence of society and nationality. When considered in the context of an employee, additional perspectives that influence are, e.g., industry, company, function, and profession (Manguin 2004). Therefore, an individual or employee does not belong to one single culture, but to a multitude of cultures, such as national, regional, corporate, and professional. Thus, we recognise that an appropriate definition of culture includes influencing factors as listed in the above, but for the purpose of this study the main focus of cultural diversity is limited to national, discipline, and corporate perspectives.

The degree of diversity depends on the number of different diversity factors (culture, discipline, qualification, gender, etc.) involved and the distance in-between each. In general, the more diversity factors, and the greater the distance, the more complex the team structure gets.

Diversity can have positive effects (synergies) and negative effects (misunderstandings, cultural clashes). Literature on this question has produced quite inconsistent findings concerning the effectiveness of diversity within organizations and groups, yet it is widely recognized that multifunctional teams perform either exceptionally well or exceptionally bad. The findings related to threats and potentials arising from diversity can be summarized as follows (Manguin, 2004):

Threats:

- diversity renders collaboration more difficult, because everybody has different expectation;
- incompatible values and beliefs about principles, such as punctuation, consensus, or hierarchy, can give rise to serious misunderstandings and can result in attitudinal struggles;
- diversity prevents homogeneity which hinders trust. In addition, it seems that multi-cultural teams are less prone to groupthink since the various views represented go against the tendency to adapt one’s ideas to those of the majority;
- in general, diversity is frequently the origin of misunderstandings and results in lower effectiveness and slower decision making velocity.

Potentials:

- different views of the world provide the opportunity to get different opinions on a certain problem and have positive impact on creativity and innovation;
- diversity enhances creativity, problem solving, and innovation in qualitative and quantitative ways due to manifold technical expertise, rendered by dissimilarity in education, training, or work experience;
- positive attitude to diversity is motivating to the workforce, especially to representatives of minorities;
- diversity broadens managers’ interpersonal skill.

Harvesting the benefits of diversity involves a very careful and mature use of the different diversity factors in a team. This means that numerous cultures should not be

inflated indefinitely for the sake of increasing diversity. Rather the cultural distance and compatibility of the participants' cultures should always be evaluated in order to leverage the group diversity in a positive direction.

2.3. Collaboration Technology and Tools

One major enabler of the virtual team's and communities' work practices is collaboration technology. Technological support for collaboration has a long tradition and dates back to the 1980s when research areas such as Group Support Systems, GSS (Nunamaker et al., 2001) and Computer Supported Collaborative Work, CSCW (Bannon & Schmidt, 1989; Crabtree et al., 2005; Schmidt & Simone, 2000) emerged. At the beginning research concentrated in developing various group-oriented communication systems as messaging and video conferencing with the aim to help cooperating actors to overcome physical distance. In a second step systems focusing on collaboration and coordination of tasks within collaborative organizational structures, such as teams and groups, were developed.

Collaboration technology is in this study defined through the specific features of collaboration support systems, i.e., as computer based systems that support communication, coordination and collaboration of individuals in specific collaboration settings. Bafoutsou and Mentzas (2002) provide an extensive overview of available collaboration technology and their features. According to them typical functionalities of collaboration systems are:

- Communication functionalities: bulletin boards, discussion, e-mail, online paging/messaging, chat, whiteboard and audio/video conferencing.
- Coordination or process structuring functionalities: task lists, project management, contact management, meeting scheduling tools, meeting minutes/records, support for specific workflow and similar.
- Collaboration functionalities: screen and application sharing, surveys/pooling, files and document sharing, document and knowledge management.

Groth (1999) makes a slightly different classification: technological support for meetings, for work, and for infrastructure. The first involves systems that support electronic meetings in which coordination and decision making are made. The second means support for work specific tasks which allows a common frame of reference and enables integration. Infrastructure denotes technology which enables cooperation and collaboration, e.g., common technology platform, shared storage space, and sufficient band width to allow virtual teams' interaction and communication.

Existing collaboration tools are challenged today by two developments: on the one hand, by new working structures as mentioned above, and on the other hand, by new emerging technologies, such as Remote Frequency Identification (RFID), Ubiquitous Computing (Fleisch & Mattern, 2005), Ambient Intelligence (Dukatel et al., 2005), Service Oriented Architectures, and Web 2.0, which enable new tools and innovative approaches for collaborative work. Ubiquitous Computing and Ambient Intelligence enable a paradigm shift where technology becomes virtually invisible in our lives. Further, existing systems have been developed with specific collaboration settings in mind or for specific tasks. It is an open question if these are sufficient for new collaboration settings and how these should be further developed. New technology and new working structures challenge, e.g., user interaction, displays, operating systems, networks, and wireless communication.

In the following, when discussion functionality of collaboration technology and tools we classify according to:

- Communication tools
- Coordination tools
- Task-specific collaborative tools
- Social software (blogs, wikis, social networking and social tagging).

Software for socializing is of particular value when members never or rarely meet face-to-face (Mirijamdotter, Somerville & Holst, 2006). Impact and relationship of different kinds of collaboration tools to productivity, creativity and innovation are also of interest but falls outside the scope of this study.

2.4. Collaboration Task and Performance

Goodhue & Thompson (1995) broadly define tasks as the action carried out by individuals or groups in turning inputs into outputs. Tasks can have different goals. For example, groups may have the task to generate ideas, chose a preferred solution, negotiate conflicting views or interests, or engage in competition with an opponent.

Task can be differentiated based on their complexity and interdependency. The nature and complexity of the task determines to a great extent the required features of ICT used by individuals to perform the task. This relationship is called task-technology fit and is the degree to which a technology assists an individual or group in performing the tasks (Shirani, Tafti & Affisco, 1999). The task-technology fit has an impact on the task outcome.

Previous research suggests that tasks that are ill-structured, ambiguous, or equivocal require rich media that can carry different types of messages (Shirani, Tafti & Affisco, 1999). Zigurs and Buckland (1998) have developed a task-technology fit theory, which relates tasks with different complexity to functionalities of various group support systems. In case the task involves mainly communication also the term task-media fit is used, which refers to the fit of communication tasks and appropriate communication media. Thus, the nature and complexity of tasks have great impact on technology requirements and on how outcomes can be measured. Further, task-technology fit and task-media fit have impact on the task outcome.

In the following the terms innovation, creativity and productivity are discussed including how these can be measured in relation to task outcome.

2.1.1 Innovation

Innovation is the process by which new ideas are put into practice. This involves the generation of new ideas, the development of these into a workable product, process or service (MacFadzean, 1998). Hence, innovation is more than just the invention of new ideas or concepts; it also involves implementation. In this study the definition proposed by OECD (2005) is applied as it additionally defines and distinguishes innovation types in organisations:

- A product innovation is the introduction of a goods or service that is new or significantly improved with respect to its characteristics or intended usage. This includes a significant improvement in technical specification, components and materials, incorporated software, user friendliness or other functional characteristics.
- A process innovation is the implementation of a new or significantly improved product or delivery method. This includes significant changes in techniques, equipment or software.

- A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

As stated, innovation is a process which includes all stages from generating ideas to implementing the elaborated concepts. However, there are numerous models to describe this process of which some are based on the assumption that innovation is a linear process while others propose a non-linear representation (Buijs, 2003). Therefore there are no agreed upon measures for the concept. Further, there is a difficulty in clearly distinguishing the novelty of a new approach or product. The OECD guidelines (2005) distinguish two survey approaches to collecting data on innovation:

- The “subject” approach refers to the innovative behaviour and activities of the company as a whole. The idea behind this is to explore the factors influencing the innovative behaviour of a firm (strategies, incentives and barriers to innovation) and the scope of innovation activities.
- The “object” approach is oriented towards collection of data about a specific innovation – usually a significant innovation of some kind in a company.

We find that based on the “subject” approach, it is possible to measure indicators of innovation and to this study this kind of assessment seems appropriate.

2.1.2 Creativity

“In a general sense, creative problem solving refers to any activity during which an individual, team or organisation attempts to produce novel solutions to ill-defined problems” (Puccio, 1999: 171). More specifically, according to Carrier (1998), creativity stands for the production of new, individual ideas that may become the raw materials for innovations if they can be successfully implemented. These two definitions, suggest that creativity can be seen as an attitude in the problem solving process; not as a stage therein.

Although, the term “creativity” seems to be clear at a first glance, the details are controversial and unclear, for example, the dependencies of creativity (Goldenberg & Mazursky, 2000; Rickards, 1985; Tan 1998). According to dispositional theory creativity is dependent on individual traits and characteristics; in the process perspective creativity can be taught; and in cultural track theory the organizational culture has a powerful impact. Apparently, none of these approaches will provide a complete, general answer to the question on creativity dependence.

The controversial nature of creativity dependence leads to that there are no generally accepted methods for increasing creativity (Goldenberg & Mazursky, 2000). It seems that the focus nowadays lies on the (organizational) context of people and how the context impacts creativity (Kristensen, 2004).

McAdam & Keogh (2004) state that creativity – as well as innovation – can be measured exactly. However, they do not explain how this should be possible, but propose some guidelines for choosing the right methods:

- performance measures should be derived from the company's strategy;
- the purpose of each performance measure should be made explicit;
- there should be clear data-collection methods;

- all stakeholders should be involved in the selection of the measures; and
- the measures should be changeable based on organizational and environmental dynamics.

For the purpose of this study, we define creativity as the process of creating new, individual ideas that may become the raw material for innovation. It seems that measuring creativity – and innovation – is only possible in respect to the specific task inside an organization; if and how creativity is enabled by eCollaboration is therefore assessed in relation to corporate specific terms.

2.1.3 Productivity

Productivity is an economical term, which describes the relation between an effort (“input”) and the benefit resulting from this effort (“output”):

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

An important aspect related to impact of ICT on productivity is the so called “IT productivity paradox”. This term is attributed to the economist Robert Solow (OECD 2003). Solow observed earlier, “...that computers are everywhere except in the productivity data”. During the 1980s and 1990s many studies showed that investments in ICT had negative or zero impact on productivity growth. However, new studies show that, the use of ICT is positively linked to company performance (OECD 2003), but not all companies benefit equally from investments in ICT. There is significant interdependence of ICT and the existing human, business and technology resources of a company; ICT investments result in productivity increase only if they are aligned to the company strategy as well as integrated with complementary human and business resources, such as open organization, open communication, CEO commitment to IT, team-oriented organizational structure, and open and trustful relationships with suppliers (Powell & Dent-Micallef 1997).

Several published case studies show that collaboration technology might have positive effects on productivity (e.g., Collaboration@Work, 2006; Majchrzak et al., 2000; May & Carter, 2001). The case studies also show that productivity measurements are task specific. Therefore in the subsequent activities of this study specific productivity measures for each case is assessed according to the customs of each company.

3. Methodology and Cases

As the main goal of the study is to explore and describe different eCollaboration settings including their impact, “explorative” and “descriptive” case studies have been conducted (Eisenhard, 1989; Yin, 1993; 1994). The cases that have been chosen are organizations, teams, or communities with different kinds of eCollaboration settings, Table 2. In total ten case studies have been conducted by seven members of the research team and documented according to a predetermined structure: context, description of data collection, description of task, description of collaboration setting, collaborative tools and efforts, impact, summary of findings, and analysis and conclusions (Stanoevska-Slabeva et al., 2007). In order to validate the primary data collected, where possible and applicable, multiple interviews per case were conducted and at least one feed-back loop has been performed for authorization of results by the case organization.

Industry	Short description of the case	Country	Methodology
General, multi-national bank	Description of a new way for developing banking software (i.e. an online payment system) by means of off-shoring and eCollaboration with engineers abroad.	Switzerland	Unstructured interviews
International Free Software / Open Source Community	Description of an open source community and the way they work.	Global	Unstructured interviews
International telecom company	Description of a creative design team	Finland	Unstructured interview
International telecom company	Case study related to the telecom business as such and its inherent global collaboration.	Sweden	Unstructured interviews and secondary information
International telecom company	Case study based on an employee's e-collaboration during leisure hours to develop a new business model that includes mobile service. The case also comprise experience of solely virtual collaboration, with no budget, and using free software collaborating tools.	Sweden	Unstructured interview
Global ICT and consultancy company	Description of an innovative way to pour knowledge and innovative thinking of the whole organization, supported by ICT tools.	Belgium	Unstructured interviews and secondary data
Global ICT and consultancy company	Case study about collaboration within a large, global company. Describes tools and processes.	Belgium	Unstructured interviews and secondary information
Universities and research institutes from five European countries, including relevant industrial partners	The case concerns a project that aims at realizing distance laboratory training via videoconferencing in a manner that the learning effect gained during traditional laboratory training is maintained. Additionally it concerns e-collaboration when developing methods for managing the distance-based laboratory training.	Sweden	Unstructured interviews and secondary information
IT consultancy company	A SME that runs its business in several international collaborative settings. Additionally, the company has a member of the management team and an office in Malaysia. The case describes the eCollaboration in the company, and between the company, its customers and its international consortium partners.	Sweden	Unstructured interviews and secondary information
German Ministry of Education, Youth and Sports	Implementation of a special teacher program called "Reinventing Education" focused on raising standards of student achievement in Brandenburg schools and helping make the system more effective.	Germany	Unstructured interviews, project documents and workshops

Table 2. Overview of cases.

The conducted case studies, including methodology for data gathering, are summarized in Table 2.

There is a lot going on concerning eCollaboration in companies, but also within research organizations and in leisure time. The case studies that have been considered handle different kinds of teams and collaborative efforts. Some of the cases have a company focus and regard eCollaboration as everyday practices within a company; others describe a task or effort performed by a team. Depending on the features of the task involved the cases can be classified in: cases that illustrate creative collaboration, cases that illustrate collaboration focusing on increasing productivity, and cases that illustrate open innovation and open source communities.

Major results of the case studies are discussed in the subsequent section.

4. Discussion of Results

In the following some preliminary results are presented and discussed. These are related to organisational patterns and new working structures, use of collaboration technology, and e-Collaboration's impact on creativity, innovation and productivity.

4.1 Organisational Patterns, Diversity and Performance

In all cases individuals involved in eCollaboration are more or less diverse. Most eCollaboration settings observed are diverse in terms of culture, location and size. In several companies it is common practice to put employees from various locations to work together on specific tasks; different functions may be in different locations, placed at different sites, while differences in functional and educational backgrounds provide more specialised input to a task. Functional diversity is common in all organizations and is considered to have positive effect on creativity and innovation including positive impact on problem solving. These effects are also confirmed, among others, by Kristensen (2004) and Richards (1985).

However, as found by e.g. Manguin (2004), diversity is the origin of misunderstandings; to avoid this kind of misunderstandings, case results point at a dominance of specific corporate and professional perspective in favour of the national or regional culture. Thus, in these situations the agreed behavioural norms that are specific for a group to survive and coexist (Elashmawi & Harris, 1993) are based on the company culture rather than the social norms of the region.

Common knowledge among several of the interviewed is that special management measures are needed to reduce the negative aspects of diversity. For example cultural training, time to get to know each other and preferable meet face-to-face before beginning to e-collaborate. In general, diversity requires time for developing common ground and understanding. Additionally, we found that corporate culture that explicitly appreciates diversity is motivating. In Manguin's research (2004) this factor is confirmed and identified as a potential for well performance in multifunctional teams.

A different strategy for location diversity, practiced to reduce lead time and costs of labour by giving over work tasks to another time zone, was to off-shore some (often more routine based) tasks. This led to a need to clearly define processes including common methods and tools to be used. Such clarification showed to be beneficial for all involved parties in that it made explicit the structure of involved work processes which, in turn, enabled changing and improving these. This strategy

can have a positive effect when the tasks are in sequential order and the work process, including tasks and subtasks, can be clearly defined and structured. However, other cases showed that the impact was less positive when the interdependency of the tasks is mutual or pooled.

Finally, individuals that collaborate in open source or open innovation settings are part of a more dynamic structure while teams in organizations have a rather fixed size and structure and follow similar work practices as when being co-located. Teams in open source or open innovation settings can be resembled to communities of practice in that these provide an environment in which members share, construct, and learn together (Kling & Hara, 2002) and for these reasons use different kinds of ICT-artefacts to interact and communicate (Mirijamdotter, Somerville & Holst, 2006; Schoberth, Preece & Henzl, 2003).

4.2 Collaboration Technologies and Performance

All cases showed that there are numerous collaboration tools available for eCollaboration either as commercial software or as open source tools. However, the tools are with different functionalities. Based on the functionality the tools discussed in the cases can be classified in communication and collaboration tools, and tools for specific tasks. In some companies it was 'a rule' to log on to a specific software which informed other members (often of a virtual team) to know who was in the office. By such a procedure it was know who were available for short messaging or for taking a call. The software that are usually grouped as social software (blogs, wikis, etc.) were not mentioned as common in collaboration and in work practice.

Open and dynamic collaboration settings, which are not tightly bound to a company, tend to use open source collaboration software, while established companies use commercial collaboration tools. The security rules of an organisation often put hindrance for using open and free collaboration software. This was a problem, particularly for universities and SME's, when collaborating in international settings. Commercial collaboration tools can be quite costly and public organisations, and organisations in less high-economy countries, cannot afford this. Further, open and free collaboration software, although usually less reliable than the commercially provided, are a necessity for communities that collaborate without monetary resources.

None of the companies considered in the case studies, except one, do not have a specific management approach to collaboration technology. Teams and individuals are free to chose and use available technology. The company that is the exception provides a set of collaborative tools and methods gathered on its intranet. Basic information about each tool, its use and a link for downloading are supplied and supplemented by success stories, information about good practice and user experiences.

Technology that provides support for communication and information sharing were in general experienced as adequate for furthering the work while technology for supporting interaction and creative processes were experienced as insufficient. In the latter a need for physical meetings were often suggested. The experience was that creative processes were dependent on people interactions which enable associations that are based on input through as many senses as possible. Therefore it was valued to be able to sketch and to follow physical activities in the interactions, including body language of people. None of the known and used technologies in a majority of the cases were sufficient for this kind of need.

New emerging technologies and their potential for collaborative work were not explicitly discussed in the case companies. It was stated that in engineering based companies new technology is often introduced beginning by the interest of one or a few employees. If they find the technology reliable and usage satisfactory it may gradually spread in the company and may even be adopted formally as standard software.

One major factor affecting the impact of technology on productivity, innovation and creativity is the task-media fit for tasks involving mainly communication and the task-technology fit for tasks involving collaboration and coordination (Shirani, Tafti & Affisco, 1999; Zigurs & Buckland, 1998). A good task-media and task-technology fit is usually achieved by task specific tools. In case the technology does not support the specific requirements of a process, the process needs to be adjusted to the technology and this leads many times to less optimal results. Additionally, a low task-media and task-technology fit may lead to non-usage of the technology even if it is stated as required. People do not seem to bother with technology that do not support their work in a satisfactory or sufficient manner.

4.3 eCollaboration and Performance

Most cases confirmed that eCollaboration technologies enable higher productivity by providing support for routine collaboration tasks. The main consist of: providing support for decision and coordination meetings, e.g., telephone, web, and video conferences; sharing information and documents via, e.g., shared work spaces and data bases; supplying common platforms which enable cooperation and integration. These categories are in line with Groth's (1999) presented in the above. Further, in off-shoring businesses the productivity increases due to 'work around the clock', provided that tasks are structured, clearly defined and sequential, and that methods and tools are standardised. However, when considering additional diversity aspects the productivity impact may be negative due to, e.g., cultural misunderstandings and insufficiently clarified tasks and work processes.

Moreover, when dealing with creative and unstructured tasks it is found that the collaborative setting needs to be collocated to be productive. If this is not possible, if additional gains are sought for by being distributed, the process needs to be planned for and managed in a different manner compared to being co-located (Mirijamdotter, Somerville & Holst, 2006). This is also illustrated in the case that focused on pouring from a large organisation's knowledge and innovative thinking.

The cases confirmed that eCollaboration has positive effects on creativity. It enabled new type of creative processes, for example, open source communities or open innovation. It furthermore enabled the creation of a great number of ideas and the efficient involvement of a high number of participants. Thereby, following Carrier's (1998) reasoning, the likelihood of getting good raw materials for innovations, which can be successfully implemented, should increase.

Further, following Carrier (1998) and Puccio (1999), creativity can be seen as an attitude in the problem solving process. This kind of approach was visible in how members of a team or a company interacting by means of instant messaging, like ICQ. They contacted each other when they needed quick interaction and suggestions on 'solutions' of an encountered problem.

However, in most cases it was well recognised that creativity is dependent on individual traits and characteristics; creativity was not measured, nor assessed explicitly, neither on the individual level, nor on team level. Creativity as such was

not important other than when it comes to quickly solving problems. And in such cases it was thought of more as based on experience, not on creative thinking.

With respect to innovation two different kinds of impacts of eCollaboration were observed. First, eCollaboration enabled process innovation in the sense of realizing new types of innovative processes. Examples of new type of innovative collaboration processes enabled by eCollaboration are open innovation, open source communities, efficient off-shoring processes, and collaboration for the purpose of sharing expensive equipment. Second, eCollaboration supported innovation in terms of making possible the development of a new business model (eventually leading to a new product) as it enabled a new kind of collaborative process which, in turn, supported creative processes to a certain degree and managed routine tasks. These two innovation types correspond to two of the innovation categories distinguished by OECD guidelines (2005):

- process innovation which involves the implementation of a new or significantly improved product- or delivery method;
- product innovation which is the introduction of a new or significantly improved goods or service with respect to its characteristics or intended use.

Additionally we ponder on whether organisational innovation can also be attributed to the cases use of eCollaboration tools and technologies.

- An organisational innovation is the implementation of a new organisational method in the company's business practices, workplace organisation, or external relations (OECD, 2005)

and this is certainly the case in most of the studied companies and organisations.

However, to really measure innovation has proven hard. Counting the number of applied patent has been one approach. Whether a patent application is the result of an innovation or some other approach to product development is difficult to distinguish. Further, although innovation is appreciated few companies intentionally support and reward innovative behaviour; factors influencing innovative behaviour, such as strategies, incentives, and activities related to innovation are rare. Nevertheless, in subsequent analyses, provided that the data is adequate, the research team will continue the assessment of the cases with respect to impact on task output.

5. Conclusion

The focus of this paper is eCollaboration, new working structures and impact on innovation, creativity and productivity. The research builds on ten case studies of corporate organisations, teams, and communities with different kinds of collaborative settings. Included are cases that illustrate creative collaboration, cases where eCollaboration increases productivity, cases that use eCollaboration in their every-day practice, and cases that include open innovation and open source communities. Basic definitions, on which the research framework is based, are given and preliminary results of the cases are discussed. Main findings so far relate to organisational patterns and new working structures, use of collaboration technology, and e-Collaboration's impact on creativity, innovation and productivity.

In all cases individuals involved in eCollaboration are more or less diverse. Functional diversity is common in all organizations and is considered to have positive effect on creativity and innovation including positive impact on problem solving. Special management measures are needed to reduce the negative aspects of diversity.

However, diversity in location, i.e., different time zones, can be an advantage in that it facilitates ‘work around the clock’.

There are numerous collaboration tools available for eCollaboration with different functionalities and either as commercial software or as open source tools. Established companies tend to use commercial software while smaller companies, public organisations and communities prefer the open and free (or less expensive) software tools. Specific management approaches to collaboration technology are rare. Teams and individuals are often free to choose and use available technology. Technology that provides support for communication and information sharing were in general experienced as adequate for furthering the work while technology for supporting interaction and creative processes were experienced as insufficient.

Most cases confirmed that eCollaboration technologies enable higher productivity by providing support for routine collaboration tasks such as support for meetings, sharing information and documents, and supplying common platforms which enable cooperation and integration. However, when dealing with creative and unstructured tasks collaborative settings need to be collocated to be productive, or the process needs to be very well-planned and managed.

eCollaboration has positive effects on creativity in that it enables new type of creative processes including creation of a great number of ideas and efficient involvement of a high number of participants.

Concerning innovation, eCollaboration enabled process innovation, in the sense of realizing new types of innovative processes, and supported product innovation in terms of making possible the development of a new business model which was developed by a new kind of collaborative process. Further, we find evidence for organisational innovation in that eCollaboration permitted new methods in business practices, workplace organisation, and external relations.

Finally, it is an open question whether existing technology is sufficient for new collaboration settings and new working structures and how these should be further developed. Further questions that arise are: What is the impact and relationship of different kinds of collaboration tools to productivity, creativity and innovation? How should collaboration tools and work processes be designed in order to boost productivity, innovation and creativity? Additionally, to fruitfully analyse and discuss impact on task outcome we may need different categorisations for collaborating technology depending on nature of task and focus on task outcome.

Further and subsequent analyses include cross-case analysis and impact on research framework to adequately reflect basic concepts in eCollaboration and task output.

Acknowledgements: We are most grateful to the companies that provided us with the material we needed for this study and to the EU for accepting our tender for call no. 2005/S 152-151281, thus providing means for this research. We also thank two anonymous reviewers for their input to a first version of this paper.

6. References

- Alt, R. (2003). “Collaborative Computing – der nächste Schritt im Business Networking”. In: Beyer, L., Frick, D., Gadatsch, A., Maucher, I., and Paul, H. (eds.), *Vom E-Business zur E-Society. New Economy im Wandel*. München: Hampp
- Alt, R. and Österle, H. (2004). *Real-time Business*, Springer, Heidelberg, Germany.

- Andriessen, E.J.H. and Vartiainen, M. (2006). *Mobile Virtual Work - A New paradigm?*. Heidelberg, Germany: Springer.
- Bafoutsou, G. and Mentzas, G. (2002). "Review and functional classification of collaborative systems". *International Journal of Information Management*, 22: 281-305.
- Bannon L.J. and Schmidt K. (1989). "CSCW: Four Characters in Search of a Context", *Proceedings of the First European Conference on Computer Supported Cooperative Work, ECSCW'89*. Gatwick, London, 13-15 September, pp. 358-372.
- Buijs, J. (2003). "Modelling Product Innovation Processes, from Linear Logic to Circular Chaos". *Creativity and Innovation Management*, 12 (2): 76–93.
- Carrier, C. (1998). "Employee Creativity and Suggestion Programs: An Empirical Study". *Creativity and Innovation Management*, 7 (2): 62–72.
- Chesbrough, H.W. (2003). *Open Innovation -The New Imperative for Creating and Profiting from Technology*, Boston, MA.: Harvard Business School Press.
- Collaboration@Work (2006). *The 2006 report on new working environments and practices*, European Commission, Luxembourg Office for Official Publications of the European Communities, October.
- Crabtree, A., Rodden, T., and Benford, S. (2005). "Moving with the Times: IT Research and the Boundaries of CSCW", *Computer Supported Cooperative Work* 14: 217-251.
- Ducatel, K., Bogdanowicz, M., Scapolo, F., Leijten, J., and Burgelman, J.C. (2005). "That's What Friends are For - Ambient Intelligence (AmI) and the Information Society in 2010". In Zerdick, A., Picot, A., Schrape, K., Burgelman, J-C., Silverstone, R., Feldmann, V., Wernick, Ch., and Wolff, C. (eds.) *E-Merging Media Communication and the Media Economy of the Future*. Berlin: Springer.
- Easton, G. (1992). "Industrial Networks: A Review", in B. Axelsson and Easton, G. (eds.) *Industrial Networks: A New View of Reality*, pp. 3-27, London, UK: Routledge.
- Elashmawi, F. and Harris, P. R. (1993). *Multicultural Management: New Skills for Global Success*. Houston, TX: Gulf Publishing Company.
- Eisenhard, K. (1989). "Building Theories from Case Study Research". *Academy of Management Review*, 14 (4): 532-550.
- Fleisch, E. and Mattern, F. (2005). *Das Internet der Dinge*. Heidelberg: Springer Verlag.
- Gartner (2006). "Hype Cycle for Collaboration and Communication". Stamford: Gartner.
- Goldenberg, J. and Mazursky, D. (2000). "First We Throw Dust in the Air, then We Claim We Can't See: Navigating in the Creativity Storm". *Creativity and Innovation Management*, 9 (2): 131–143.
- Goodhue, D.L. and Thompson, R.L. (1995). "Task-Technology Fit and Individual Performance". *MIS Quarterly*, 19 (2): 213-236.
- Groth, L. (1999). *Future Organizational Design. The Scope for the IT-based Enterprise.*, Chichester: Wiley.
- Gudykunst, W. B. (1994). *Bridging Differences: Effective Intergroup Communication (2nd ed.)*. Thousand Oaks, CA: SAGE Publications Inc.
- Gulati, R., Nohria, N., and Zaheer, A. (2000). "Strategic Networks", *Strategic Management Journal*, 21.
- Hamel, G. and Prahalad, C.K. (1994). *Competing for the future*, Boston, MA.: Harvard Business School Press.
- Harris, P. and Harris, K. (1996). "Managing Effectively Through Teams", *Team Performance Management: An International Journal*, 2 (3): 23-36.
- Holst, M. (2007). *Enabling Boundary-Crossing Collaboration for Innovation - Issues for Collaborative Working Environments*. Doctoral Thesis 2007:03, Department of Business Administration and Social Science, Luleå University of Technology, Luleå, Sweden.
- Holst, M., and Mirijamdotter, A. (2006). "Framing Multidisciplinary Teams: Sense making through the POM-model". In Basden, A., Mirijamdotter, A., and Strijbos, S. (eds.) *Integrating Visions of Technology - Proceedings of the 12th Annual CPTS Working Conference*, pp: 111-140.
- Jarvenpaa, S. L. and Blake, I. (1994). "The Global Network Organization of the Future. Information Management Opportunities and Challenges", *Journal of Management Information Systems*, 10 (4): 25-57.
- Katzenbach, J. and Smith, D. (1993). *The Wisdom of Teams - Creating the High Performance Organization*, Boston: Harvard Business School Press.
- Kling, R., and Hara, N. (2002). IT Supports for Communities of Practice: An Empiricallybased Framework. In *CSI Working Paper*.
- Kock, N. (2005). "What is eCollaboration?", Editorial Essay in *The International Journal of e-Collaboration*, 1 (1): i-vii.
- Kock, N. & Nosek J. (2006). "Expanding the Boundaries of E-Collaboration". *IEEE Transaction on Professional Communication*, 48 (1): March 2006.

- Kristensen, T. (2004). "The Physical Context of Creativity". *Creativity and Innovation Management*, 13 (2): 89–96.
- Lave, J., and Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.
- Lipnack, J. and Stamps, J. (2000). *Virtuelle Teams - Projekte ohne Grenzen: Teambildung - Virtuelle Orte - Intelligentes arbeiten - Vertrauen im Team*. Wien: Ueberreuter.
- MacFadzean, E. (1998). "The Creativity Continuum: Towards a Classification of Creative Problem Solving Techniques". *Creativity and Innovation Management*, 7 (3): 131–139.
- Majchrzak, A., Rice, R.E., Malhotra, A., and King, N. (2000). "Technology Adaptation: The case of a computer-supported inter-organizational virtual team", *MIS Quarterly*, 24: 569-600.
- Manguin, O. (2004). *Managing multicultural R&D teams: an in-depth study of a research project at CERN*. Dissertation of the University of St. Gallen, No. 2820.
- May, A. and Carter, C. (2001). "A case study of virtual team working in the European automotive industry", *International Journal of Industrial Ergonomics*, 27: 171-186.
- McAdam, R. and Keogh, W. (2004). "Transitioning Towards Creativity and Innovation Measurements in SMEs". *Creativity and Innovation Management*, 13 (2): 126–136.
- Mirijamdotter, A., Somerville, M.M., and Holst, M. (2006). "An Interactive and Iterative Evaluation Approach for Creating Collaborative Learning Environments". *The Electronic Journal of Information Systems Evaluation*, 9 (2): 83-92.
- Mohrmann, S.A., Cohnen, S.G., and Mohrman A.M. (1995). *Designing Team-based Organizations - New Forms of Knowledge Creation*. San Francisco, CA: Jossey-Bass Inc., Publishers.
- Nunamaker, J.F., Briggs, R.O., Mittleman, D.D. Vogel, D. R., and Balthazar, P.A. (2001). "Lessons from a Dozen Years of Group Support Systems Research: A Discussion of Lab and Field Findings", *Journal of Management Information Systems*, 13 (3): 163-207.
- OECD (2003). *ICT and Economic Growth - Evidence From OECD Countries, Industries and Firms*.
- OECD (2005). *Oslo Manual - Guidelines for Collecting and Interpreting Innovation Data*.
- Powell, Th. C. and Dent-Micaleff, A. (1997). "Information Technology as Competitive Advantage: The Role of Human, Business, and Technology Resources". *Strategic Management Journal*, 18, (5): 375-405.
- Puccio, G. J. (1999). "Creative Problem Solving Preferences: Their Identification and Implications". *Creativity and Innovation Management*, 8 (3): 171–178.
- Rickards, T. (1985). *Stimulating Innovation: A Systems Approach*. London: Frances Pinter.
- Robbins H. and Finley, M. (1995). *Why Teams Don't Work - What Went Wrong and How to make it Right*. Princeton: Peterson's/Pacesetter Books.
- Schoberth, T., Preece, J. and Heinzl, A. (2003). "Online Communities: A Longitudinal Analysis of Communication Activities", *Proceedings of the 36th Hawaii International Conference on Systems Sciences (HICSS 36)*, pp. 216a.
<http://csdl2.computer.org/comp/proceedings/hicss/2003/1874/07/187470216a.pdf>
- Schmidt, K. and Simone C. (2000). "Mind the gap! Towards a Unified View of CSCW", *Proceedings of the Fourth International Conference on the Design of Cooperative Systems*. May 23-26, Sophia Antipolis, France.
<http://www-sop.inria.fr/acacia/Coop/Coop2000/Coop2000-Programme.html>
- Shirani, A., Tafti, M.H.A. and Affisco, J.F. (1999). "Task and Technology Fit: A Comparison of Two Technologies for Synchronous and Asynchronous Group Communication". *Information & Management*, 36: 139-150.
- Stanoevska-Slabeva, K.; Deruytter, J., Heikura, T., Hoegg, R., Mirjamdotter, A.; Netzow, J., Nilsson, M. (2007). "WP3 deliverable: Case studies of diverse teams and collaborative working environments". Deliverable of the study *Collaborative work: productivity, creativity and innovations impacts and implications*. Internal Project Document.
- Tan, G. (1998). "Managing Creativity in Organizations: a Total System Approach". *Creativity and Innovation Management*, 7 (1): 23–31.
- Yin, R. (1993). *Application of Case Study Research*. Thousand Oaks: Sage Publications.
- Yin, R. (1994). *Case Study Research - Design and Methods, 2nd ed.* Thousand Oaks: Sage Publications.
- Zigurs, I. and Buckland, B.K. (1998). "A theory of task/technology fit and group support systems effectiveness". *MIS Quarterly*, 22: 313-334.

Building Commitment and Trust to ICT Collaboration in Partnership Networks

Timo Kestilä

Turku School of Economics
timo.kestila@tse.fi

Marko Mäkipää

University of Tampere
marko.makipaa@cs.uta.fi

Hannu Salmela

Turku School of Economics
hannu.salmela@tse.fi

Lauri Salmivalli

Turku School of Economics
lauri.salmivalli@tse.fi

Abstract. During the past two decades, industrial restructuring, large-scale downsizing, vertical disaggregation, outsourcing, and elimination of layers of management have guttered the mighty multidimensional organizations of the 20th century. Many organizations have found themselves to be in middle of a value network, where they are highly dependent on the resources, capabilities and information of their partners. Information technology has been a central enabler in the process toward network society. Despite the critical role of computers in inter-organizational arrangements, coordination of IT decisions within these networks is a fairly unexplored area, both in research and in practice. The processes through which the orchestration of IT in networks takes place are largely hidden. In this research-in-progress paper we investigate the processes through which networks can reach agreements on the use and management of IT. We present some preliminary findings in areas of trust, management, vision, mission and shared goals in the context of networks' ICT governance.

Keywords. ICT, IOS, commitment, partnership, network, collaboration, IT governance.

Introduction

During the past two decades, industrial restructuring, large-scale downsizing, vertical disaggregation, outsourcing, and elimination of layers of management have gutted the mighty multidimensional organizations of the 20th century. Replacing them are leaner, more flexible firms focused on a core technology and process, laced in a network of strategic alliances and partnerships with suppliers, distributors, and competitors (Achrol 1997).

Many organizations have found themselves to be in the middle of a value network, where they are highly dependent on the resources, capabilities and information of their partners. Efforts to seek network level coordination in business processes, resources and capabilities have become a key challenge. Concepts like “extended enterprise” and “orchestration” have assisted managers in identifying the new managerial challenges that the changing economy has brought to them.

Information technology (IT) has been a central enabler in the process toward network society. The complexity of the alliances, of subcontracting agreements, and of decentralized decision-making would have been simply impossible to manage without the development of computer networks (Castells 1996). Despite the critical role of computers in inter-organizational arrangements, coordination of IT decisions within these networks is a fairly unexplored area, both in research and in practice. The processes through which the orchestration of IT in networks takes place are largely hidden.

Ability to create information partnerships has led several success stories (Porter and Millar 1985; Johnston and Vitale 1998). Most examples of competitive use of IT in the private sector have been based on inter-organizational arrangements. Typical examples include sharing of data within a supply chain, creating industry infrastructures that enable customers to interact with all possible suppliers and sharing customer information between unrelated businesses to improve customer loyalty. Knowledge integration is a recent trend in inter-organizational collaboration. Success stories provide evidence of the potential that IT has – if the managers in partner organizations are able to use it.

However, many initiatives to coordinate IT decisions fail within networks. These failures are not necessarily very visible and thus get very little attention. The idea of increasing coordination in processes, information, systems and infrastructure is quietly terminated. The negotiations go on endlessly but no commitment is achieved, the project is scaled down to a “pilot” that is never even intended to be implemented further. The project may also eventually be started - but fails because of lack of initial commitment. The core group, managers working together, simply have not been able to find a way to get the institutional support for their innovative ideas.

This invisible problem is of particular significance in the Finnish context. Some success stories of inter-organizational IT alliances do exist in e.g. paper, wholesale, and banking industries and in some areas of public sector, like sharing of automotive register information and tax authority's tax proposal arrangements (Suomi 2005). Yet Finnish companies have been slow in adopting new innovative technologies. Many industrial networks have made very little conscious efforts to move towards integrated IT infrastructures that would support both the large and small companies – inter-organizational systems mean some point-to-point IT solutions. In the public sector, individual agencies still collect data to internal databases, with very little sharing of information with neither other public agencies nor private companies who might make use of the data.

The tendency of Finnish companies and public agencies to design their own systems has also slowed down innovations within the Finnish Information and Communication Technology (ICT) sector. Finding a company for a “pilot” is easy, but getting the pilot to commercial success is very difficult. Selling the innovative idea to potential users is often simply too slow and laborious. Ability to create information partnerships between different types of organizations, large and small, private and public would make the innovation diffusion process faster and thus provide a fruitful home market for exporting the innovations abroad.

This research investigates the processes through which networks can reach agreements on the use of IT. The research problem is formulated as follows:

How to build and maintain partners' commitment to IT collaboration and how to increase trust in an inter-organizational network

The practical objective is to provide methods for the managerial group, who is seeking commitment of different partners to foster a specific IT related collaborative idea. It is suggested, however, that the networks differ in terms of dominant coordination mechanisms. Hence, the group should employ methods that fit with the general coordination style of the network.

The scientific purpose is to explain the outcomes of early negotiations, i.e. why the process succeeds or fails. We acknowledge the dynamic nature of networks: the explanations for outcomes are process theories, rather than variance theories (Markus and Robey 1988). Preconditions and situational variables are not, as such, sufficient to explain outcomes. The outcomes result from the interplay between initial conditions, contextual changes, and process events (Pettigrew 1985).

The empirical data of the study is gathered from two networks. One was failure and the second one was intermediate success. Both ICT networks were in early stages and research was conducted with action research approach.

Background literature

Within information systems science, the research draws from the research tradition of inter-organizational systems (IOS). While majority of IOS research focuses on implementation issues, also commitment building processes have received some attention. In the initial phases of network, nurturing championship is critical for the success of eventual IOS project. Champions are needed to inspire stakeholders in different organizations through transformational leadership behavior (Kumar and Crook 1999). In similar vein, Kumar and Crook state the importance of collaboration between members in different organizations levels.

Research on strategic IS management planning (SISP), and more recently that of IT governance, will also be used as a theoretical background. While most of the studies in this area address IS management and governance mainly as taking place within a single firm, some researchers have already identified the need to incorporate network level considerations. For instance, Finnegan et al. argue that there is growing need for inter-organisational SISP planning (Finnegan, Galliers et al. 1999). This argument is further developed by Salmela and Spil (Salmela and Spil 2006). The planning in IOS context needs to involve stakeholders in different organisational levels and is often based on agreements (Wassenaar and Gregor 2001).

The research does, however, also draw from the more general network research tradition that has evolved in different disciplines. Perhaps the most fundamental difference between a network and an organization is lack of a single authority to ensure coordination of actions. Absence of a single authority has led networks to employ a wide array of mechanisms to be used for building and maintaining commitment to joint efforts. These mechanisms have intrigued researchers in many fields, such as economics (Williamson 1985), strategic management (Thorelli 1986), organization science (Ouchi 1979), marketing (Wilkinson 2001), sociology (Leblebic, Salancik et al. 1991), information systems (Malone, Yates et al. 1987) (Choudhury 1997) and strategic information systems planning (Johnston and Vitale 1998).

In order to classify different methods in commitment building processes, we distinguish between four ideal types of networks:

- (1) Clan type relational networks where coordination is based on social bonds and personal contacts.
- (2) Bureaucracy type hierarchic networks that rely on the authority of one strong network partner for coordination.
- (3) Market type contractual networks where coordination is achieved through negotiation and enforcement of contracts.
- (4) Strategic type long term network where the coordination is based on inter-organizational levels goal congruence and trust.

The distinction is based on (Jarillo 1988) work on strategic networks. The interplay between these basic governance mechanisms has, however, characterized the discussions about networks in many different disciplines. In essence, Adler suggests that we ask of networks “whether the content of their constituent ties is market exchange, hierarchical authority, or community trust” (Adler 2001) p. 219).

Finally, because networks in Finland often involve both public and private players, literature on public administration will be used to add insights to the theoretical framework. The differences between public and private sector management have been discussed widely in management and organization sciences. Allison (Allison 1980) has classified the differences into three groups:

- Differences in environmental characteristics: market exposure, legal, formal constraints, and political influence
- Differences in the relationship between environment and organization: coerciveness, scope of impact, public scrutiny and expectations
- Differences in organizational factors: goal complexity, authority relations, performance, incentive structures and personal characteristics (Kickert, E.-H et al. 1997)

Governance in complex networks requires distinctive management practices from traditional public sector management: Government is not the single dominant actor that can unilaterally impose its will: hierarchical, central top-down steering does not work in networks that have no ‘top’. All in all, network manager often operates from a comparatively powerless position with little hierarchical means at its disposal, yet there are several different strategies that network manager can utilize. (Kickert, E.-H et al. 1997)

The transactional-cost theory of trust contends that a potential trustor assesses the cost and benefit inherent in trusting another party. The cost is assessed on the basis that the trustee may engage in opportunistic or detrimental behaviour so as to maximize self-interest. (Granovetter 1985) asserts that this type of economic behaviour is an intrinsic component of the commitments made in social relationships and consequently if a person confirms that a company or an individual continues to keep their promises, the trust between both parties strengthens. (Ibbott and O’Keefe 2004)

Trust and conflict are inherent issues of any organizational arrangement and central for knowledge sharing (Panteli and Sockalingam 2005). In current global network era knowledge has become a key source for continuous innovation and competitiveness (Blomqvist, Hurmelinna et al. 2005). Alliance partners are expected to share their skills, expertise and competencies for mutual benefit and thus such partnership rely on trust (Panteli and Sockalingam 2005). Companies are not ready to share valuable information for partners unless they can be sure that they won’t abuse it unfairly.

Loss of control and lack of trust appear as the most important factors in failures of cooperation and the most important reason why firms avoid cooperative arrangements with other firms (Williams 1997). Trust is not only essential for learning and knowledge sharing but also because of the IOSs used in cooperation. This is supported by IS literature where trust is seen to be a crucial and important factor in success of IOS (Williams 1997) as well as in e-commerce (Gefen, Karahanna et al. 2003). IOS also intensify interactions between cooperating partners, for example, when organizations are allowed not only to enter and retrieve but also to manipulate data (Johnston and Vitale 1998). Recognition of this has led researchers to emphasize the importance of mutual trust and relationship management to the successful use of IOS (Williams 1997).

To be able to cooperate, companies need to have at least some trust to partners. We here make a distinction between “calculative” trust ‘based on the rational motivation of participating in value-adding resource complimentary’ and “behavioural” trust ‘based on the well-intended beliefs and optimistic expectations that another firm will perform positive actions and avoid negative actions towards one’s own firm’ (Larsson, Bengtsson et al. 1998). To engage in inter-organizational cooperation company probably have some rational trust to partners. The deeper forms of cooperation, however, require development of behavioural trust as well.

Trustworthiness has been found to be potential source for competitive advantage (Barney and Hansen 1994). However, sometimes it might be difficult to distinguish between partners who are trustworthy and those that only claim to be trustworthy. Since one cannot reliably distinguish between these types of partners, legal and contractual protections are a rational and effective means of assuring efficient cooperation (Barney and Hansen 1994). Importance of written agreements should not be undervalued even there usually exists a will to go through negotiations in good spirit. The contracting process itself may be used purposefully to increase mutual understanding and learning, and to build up trust and commitment (Blomqvist, Hurmelinna et al. 2005)

Research method

Research approach of the study is action research. Rapoport (1970, 499) has defined action research as follows: “Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework.” This twofold view of the objectives of action research - to solve a problem for a client and to advance science - is, perhaps, the most fundamental feature of action research (Susman and Evered 1978; Baskerville and Wood-Harper 1998). This paper follows interpretivistic paradigm (see e.g. (Chen and

Hirschheim 2004)) and empirical part of this paper reports findings from two cases. Cases are described in the following section.

Cases

The findings in first case are based on researchers' action research study. Data were collected by notes and tape recording. Second case reports findings from fifteen semi-structured interviews made to main actors in the Finnish Electronic Prescription System (EPS) pilot. Interviewees were on the management level in their organizations. Patient perspective is demarcated outside the scope of the case. The interviews were recorded, transcribed to text document and analyzed with qualitative analysis software (NUDIST Vivo)

First Case: Vasso – Partial Success Story

The second case was conducted between years 2002-2007 in South-West Finland where the aim was to create information systems' governance structure for social welfare service sector in the area. In Finland, municipalities have the primary responsibility for organizing these services to their inhabitants. The social services sector is quite heterogeneous including services like children day care, services for handicapped, social work, eldercare – and substance abuse treatment and prevention service. Individual customers may, however have several social issues at the same time and need therefore multidisciplinary care (Blackburn 2001). Hence, social services are produced by a network of professional services in each municipality.

The area of South-West Finland consists of 53 municipalities with populations ranging from 245 to 175000 inhabitants. Knowledge of ICT and its governance varies a lot between municipalities. Larger cities have dedicated personnel for IS governance e.g. CIO or IT-managers, whereas small municipalities have only a part time IS support person. The cooperation between municipalities in ICT related issues was minor.

South-West Finland Centre of Expertise on Social Welfare, (Vasso) was founded in 2002 and is owned by local municipalities. The aim of Vasso was to add knowledge in cooperative manner. It provides interpersonal and – organizational networking and is a network coordinator in the region. The network structure is very similar as in tourism networks (Stokes 2006).

The objectives of Vasso are not directly related to promoting the use of IT. Most of the projects initiated by Vasso are related to the substance issues of social services. The new managing director of Vasso was, however, aware of the need for inter-municipality collaboration to promote increased adoption of IT. His background as a director of social services of mid-sized municipality had shown

him both the significance of IT and the difficulty of implementing it in small and even mid-sized municipalities.

Shortly after the foundation of Vasso, the new managing director of Vasso contacted the IS research group in the local business school. The initial group who started discussing about first actions comprised also a teacher from local school of social welfare and a development director from university hospital. The aim was set to produce an inter-organizational strategic information systems plan for social welfare in the South-West Finland. The idea was that all municipalities and third sector service providers in South-West Finland would develop a joint strategic IS plan. The formulation of a joint plan was seen as a first step for committing municipalities to collaboration in the development and implementation of IS in the social services.

Because Vasso couldn't finance the project, arranging funding for SISP was the first task. The municipalities themselves weren't interested in funding the project. After one year of investigating potential sources of funding and clarifying the arguments for the project, it received funding from the regional council of Southwest Finland. With this funding the interview based analysis was made about information systems planning in winter 2004. The interviewees were mostly municipalities' directors in social welfare.

The interviewees assessed that strong commitment to the provincial level information system plan would be difficult to reach. Most municipalities lack financial resources and personnel for developing their information systems. Also, the traditions for inter-municipality collaboration were limited. The strategy report had an informative part, which explained how IT enables new practices and models in producing social services. The implementation part suggested actions for developing area level practices that would support inter-municipality collaboration in the joint development of social service processes and supporting systems. It was also strongly recommended that there would be one full-time IT coordinator who would coordinate the projects and an area level ICT council that would initiate, and supervise the projects.

As the only ICT governance related council was founded with an idea that it would act as informative forum, where municipalities and other actors could share their experience about ICT issues. The membership is voluntary and members don't have any official status from their own organizations. The council is currently acting and is in session twice per year. The members of the council assess it as useful for sharing thoughts. Overall, the organization is much weaker that suggested in the strategic plan, but still some part of it was implemented. The area level practices developed as part of the strategy process have also implemented, but in a different project that involved four municipalities in the development of early childhood education processes and information systems (Järveläinen, Koskivaara et al. 2007).

Second Case: Implementation of Electronic Prescription System

Electronic prescription systems (EPS) are expected to solve several challenges in health care: rationalizing medication practices of physicians, providing up-to-date information on the cheapest medication available, reducing overlapping medication, reducing medication errors and adverse drug interactions, decreasing prescription handling costs, and increasing efficiency in several organizations. Furthermore, electronic prescriptions are expected to provide more accurate and up-to-date statistical information about medication practices in relation to these issues and hence increase the efficiency of pharmaceutical distribution and improve the planning of national health policy in the long run. (Niinimäki and Forsström 1997; Mundy and Chadwick 2002; Schuring and Spil 2002; Boonstra 2003; Mundy 2003; Schuring and Spil 2003; Bastholm Rahmner, Andersén-Karlsson et al. 2004; Boonstra, Boddy et al. 2004; Spil, Schuring et al. 2004).

Electronic prescription in Finland dates back into 1990's, when alternative technologies were piloted locally, including the point-to-point email solution, card-based systems with a national medication record and prescription database trials. In 2000 the Ministry of Social Affairs and Health set a project to draw conclusions on experiences of the local trials and to suggest a national concept for ePrescribing in order to harmonize the development. In 2001 was published a preliminary disquisition about electronic prescription in Finland.

In 2002, the Finnish Ministry of Social Affairs and Health started implementing the national concept suggested in the report by selecting units from health care organizations and a couple of nearby pharmacies in four different regions to pilot the national concept described in the report. A national steering group coordinated the locally organized pilots with a small budget. An experimental decree on ePrescribing was issued in 2003. It laid down provisions among other things on preparing, signing, technical content, altering and delivery of electronic prescriptions.

The construction of the system took 2 years, and the first clinical pilot started in 2004. By the end of 2004 two out of the four piloting health care units had implemented the EPS integrated into electronic patient record (EPR), pilot pharmacies still used a stand-alone system, which was not integrated into pharmacy systems and created extra work at the pharmacies. In June 2005, the third integrated EPS and the first integrated pharmacy system were implemented.

Furthermore, in the spring 2005 the organization of the national e-prescription pilot was changed thoroughly; the part time project manager of the pilot was changed to a major consultancy company, which re-organized the administration of pilot entirely. The amount of produced e-prescriptions remained still very small and at the end of 2005 only approximately 800 electronic prescriptions had been dispensed (there are approximately 40 million dispensed prescriptions in Finland annually). In June 2006 the ePrescription pilot was ended, because it had

“reached the objectives set to it”. Interviews used in this paper were collected before the pilot administration was re-organized.

Cases analysis

Prerequisite for successful IS network implementation is the motivation of actors for cooperation in project. An IS network project has little odds to prosper if all the actors perceive project goals completely differently. Respectively, one of the main missions for project management is to mesh together different interests to reach a common objective.

Commitment and trust building in case Vasso

The first case didn't attain its goals. There were many reasons for that: The municipality organizations in Finland are hierarchic. The traditions for inter-municipality co-operation especially at the management level were surprisingly limited. The decision making procedures inside each municipality are complex. Even operational level decisions are made by political councils where the members are elected citizens. Limited financial resources, lack of IS governance knowledge and personnel and very low awareness of the potential of IT among social service management and personnel were additional IT related reasons that prohibited fast progress. Due to these reasons it was difficult to show the benefits that municipalities could gain with inter-organizational IS strategy.

Probably the main learning resulted from this five years project was the inertia. Spinning network and enforcing ties was much slower than expected. Trust building in personal level wasn't difficult. People who participated in the SISP workshops learned to trust each other after one or two meetings. To get organizational level trust and commitment seemed to be much time consuming.

Commitment to implement EPS

Based on the interviews, we can say that there is exceptionally wide understanding that there is clear *raison d'être* on the national level for ePrescription system. All interviewees shared mutual understanding that EPS pilot is needed and that it could generate benefits on the national level. Expected benefits mentioned related to rationalization of medication and medication costs, bringing health care up to date and increasing the productivity of health care generally, and improving the quality of care (e.g. less errors in prescriptions).

All organizations claimed that they are committed to national implementation project, and generally respondents didn't see that there were any major conflicts of interest, only that different actors emphasize different issues which has slowed down decision making, e.g. differing opinions about data security level was

mentioned most often. Yet, five respondents reported that a certain trusteeship organization is having its own agenda, and is hindering the work of steering group.

Organizations participating in the pilot did not receive any financial incentives for participation, but instead they were expected to allocate resources for the pilot. Hence, all of the individuals participated the project among their other tasks. Part-time project manager was only person receiving salary from the project, software vendors naturally billed for the development work which was funded by the Ministry.

Organizations involved in the pilot were surprisingly committed considering the fact that generation of actual benefits is somewhat tentative, and would anyways require that significant proportion of all prescriptions would be electronic. As long as there are two systems: one for the paper prescriptions and one for electronic prescriptions, the benefits are not generated – at least in full scale – but instead costs of both systems are running. Pioneer spirit and possibility to have an influence were mentioned several times as motive to take part in the pilot.

There was a wide understanding among interviewees that organization of the project has been a failure. Time scale of the project had been drawn out constantly, the pilot was under-resourced both in terms of money and personnel, and responsibilities were not clear. Several interviewees reported that steering group was too large, and decision-making was difficult. Decision-making was aggravated further because there was no prepared drafts on basis of decision making.

Part-time project manager had little means to influence the network. There were no rewards to be offered for good performance, nor penalties for under performance. Hence, main tools to be used were based on actors' voluntary cooperation. Furthermore, project manager did not have whole-hearted trust of all actors, which in turn was seen to complicate management.

Contributions for research

This paper is a work in a progress report and hence results reported here are preliminary. However, we suggest some contributions for research and practice that this study will present in future.

Prior research on inter-organizational information systems has generated a fairly comprehensive view on the requirements for successful implementation of IOS projects and partnerships. Shared vision at the top, reciprocal IT skills, processes to ensure information quality, and contracts that ensure equal benefits to all parties have been listed.

Much less is known about the initial negotiation processes through which all these can be achieved. In our research, scientific contribution is sought in the following areas:

- New knowledge on commitment building processes that precede joint IS investment decisions or IT infrastructure harmonization efforts
- Transfer of useful concepts from background disciplines to better understand and describe commitment building processes
- Classification of alternative coordination mechanisms and identification of network contexts where coordination mechanisms should be used

A second area of potential contribution is the general partnership and network research. This literature has viewed information technology and systems largely as an external variable. The emergence and penetration of IT in the society has been viewed as a contextual change. The idea that it should be an active component in building and maintaining network relations has not been acknowledged and no guidance is given as to how to orchestrate IT decisions as part of business decisions. Because our background is in information systems, providing scientific contribution to other fields is challenging. Our objective is, however, to initiate discussions and write joint research papers with network relationship researchers in order to address the passive vs. active role of computers in networks.

Contributions for practice

Perhaps most importantly, this research should serve as a reminder that all organizations, both public and private, operate in a network consisting of several organizations. Quite often, the use of IT is not a core interest for those business managers who manage the network contracts. IT is perceived as a difficult and perhaps too rigid tool to enhance the competitiveness of the network. Networks are, however, dependent on the inter-operability of their business processes, sharing of knowledge, and integrated computerized systems. Joint decisions on IT investments and implementation of standards could enhance and harmonize the internal operations, foster knowledge sharing, and thus support the network to better achieve its objectives. Lack of such decisions can make IT a major obstacle for network development.

Summary

This paper reports a work in a progress study; our purpose is to conduct further research in the field in future. Hence, the results presented in this paper are only preliminary.

Adding IT decisions to the sphere of network level coordination is, far from easy. Even questions such as when and how to involve IT managers in negotiations is far from clear. For IT people, it may be difficult to accept that IT decisions should not be made to serve only internal purposes and needs. It is not only a question of initiating a “project”. Rather, in all IT governance areas, IT and business managers should carefully weight the gains that can be achieved with network level harmonization and orchestration.

With this study and others to come we try to contribute to IT governance research, which addresses all IT decisions made within an organization. Our research adds a new dimension to the allocation: in networked organizations, part of the decisions should be made with network partners.

References

- Adler, P. S. (2001). "Market, Hierarchy and Trust: The Knowledge Economy and the Future of Capitalism." *Organisation Science* 12(2): 215-235.
- Allison, G. T. (1980). *Public and Private Management: Are They Alike in All the Unimportant Respects? Readings in Public Administration*. C. R. T. and F. Gibson. Boston, Houghton Mifflin.
- Barney, J. B. and M. H. Hansen (1994). "Trustworthiness as a source of competitive advantage." *Strategic Management Journal* 15((Special Issue)): 175-190.
- Baskerville, R. L. and T. Wood-Harper (1998). "Diversity in information systems action research methods." *European Journal of Information Systems* 7(2): 90-107.
- Bastholm Rahmner, P., E. Andersén-Karlsson, et al. (2004). "Physicians' perceptions of possibilities and obstacles prior to implementing a computerised drug prescribing support system." *International Journal of Health Care Quality Assurance* 17(4): 173-179.
- Blackburn, N. (2001). "Building bridges: towards integrated library and information services for mental health and social care." *Health Information and Libraries Journal* 18(4): 203-212.
- Blomqvist, K., P. Hurmelinna, et al. (2005). "Playing collaboration game right - balancing trust and contracting." *Technovation* 25(5): 497-504.
- Boonstra, A. (2003). "Interpretive Perspectives on the Acceptance of an Electronic Prescription System." *Journal of Information Technology Cases and Applications* 5(2): 27-49.
- Boonstra, A., D. Boddy, et al. (2004). "The limited acceptance of an electronic prescription system by general practitioners: reasons and practical implications." *New Technology, Work and Employment* 19(2): 128-144.
- Castells, M. (1996). *The rise of the network society*. Malden, Massachusetts, Blackwell Publishers Inc.
- Choudhury, V. (1997). "Strategic choices in the development of interorganizational information systems." *Information Systems Research* 8(1): 1-24.
- Finnegan, P., R. D. Galliers, et al. (1999). *Guidelines for Effective Information Systems Planning in Inter-organisational Environments*. Proceedings of the Seventh European Conference on Information Systems, Copenhagen, Copenhagen Business School.
- Gefen, D., E. Karahanna, et al. (2003). "Trust and TAM in Online Shopping: An Integrated Model." *MIS Quarterly* 27(1): 51-90.
- Granovetter, M. (1985). "Economic Action and Social Structure: The Problem of Embeddedness." *American Journal of Sociology* 91: 481-510.

- Ibbott, C. J. and R. M. O'Keefe (2004). "Trust, planning and benefits in a global interorganizational system." *Information Systems Journal* 14(2).
- Jarillo, J. C. (1988). "On Strategic Networks." *Strategic Management Journal* 9(1): 31-41.
- Johnston, H. R. and M. R. Vitale (1998). "Creating competitive advantage with interorganizational information systems." *MIS Quarterly* 12(2): 153-165.
- Järveläinen, J., E. Koskivaara, et al. (2007). "Value-Creating E-Government Business Models for Early Education Childhood Education in Finland." *International Journal of Electronic Government Research* 3.
- Kickert, W. J. M., K. E.-H, et al. (1997). *Management Perspective on Policy Networks. Managing Complex Networks: - Strategies for the Public Sector.* W. J. M. Kickert, K. E.-H and K. j. F. M. London, Sage.
- Kumar, R. L. and C. W. Crook (1999). "A multi-disciplinary framework of the management of interorganizational systems." *The Data Base for Advances of Information Systems* 30(1): 22-37.
- Larsson, R., L. Bengtsson, et al. (1998). "The interorganizational learning dilemma: Collective knowledge development in strategic alliances." *Organization Science* 9(3): 285-305.
- Leblebic, H., G. R. Salancik, et al. (1991). "Institutional Change and the Transformation of Interorganizational Fields: An Organizational History of the U.S. Radio Broadcasting Industry." *Administrative Science Quarterly* 36(3): 333-363.
- Malone, T. W., J. Yates, et al. (1987). "Electronic Markets and Electronic Hierarchies: Effects of Information Technology on Market Structure and Corporate Strategies." *Communications of the ACM* 30(6): 484-497.
- Markus, M. and D. Robey (1988). "Information Technology and Organizational Change: Causal Structure in Theory and Research." *Management Science* 34(5): 583-598.
- Mundy, D. P. (2003). *Providing a Secure Solution For The Integration Of Electronic Prescription Transfer Within The United Kingdom National Health Service.* UKAIS PhD Consortium.
- Mundy, D. P. and D. W. Chadwick (2002). *A System For Secure Electronic Prescription Handling.* Proc. of the 2nd International Conference on the Management of Healthcare and Medical Technology, Chicago, Illinois, USA.
- Niinimäki, J. and J. Forsström (1997). "Approaches for certification of electronic prescription software." *International Journal of Medical Informatics*(47): 175-182.
- Ouchi, W. G. (1979). "A Conceptual Framework for the Design of Organizational Control Mechanism." *Management Science* 25(9): 833- 847.
- Panteli, N. and S. Sockalingam (2005). "Trust and conflict within virtual inter-organizational alliances: a framework for facilitating knowledge sharing." *Decision Support Systems* 39(4): 599-617.
- Pettigrew, A. M. (1985). *The Awakening Giant: Continuity and Change in Imperial Chemical Industries,* Blackwell Publishers.
- Porter, M. E. and V. E. Millar (1985). "How information gives you competitive advantage." *Harvard Business Review* 64(4): 149-160.
- Rapoport, R. N. (1970). "Three Dilemmas of Action Research." *Human Relations* 23: 499-513.
- Salmela, H. and T. Spil (2006). *Strategic Information Systems Planning in Inter-Organizational Networks: Adapting SISP Approaches to Network Context.* 2nd European Conference on IS Management, Leadership and Governance, Paris.
- Schuring, R. W. and T. A. M. Spil (2002). "Explaining plateaued diffusion by combining the user-IT-success factors (USIT) and adopter categories: The case of electronic prescription systems for general practitioners." *International Journal of Healthcare Technology & Management* 4(3): 303.

- Schuring, R. W. and T. A. M. Spil (2003). Relevance and Micro-Relevance for the Professional as Determinants of IT-Diffusion and IT-Use in Healthcare. *ERP & Data Warehousing in Organizations: Issues and Challenges*. G. Grant. Hershey, Idea Group Publishing: 218-231.
- Spil, T. A. M., R. W. Schuring, et al. (2004). "Electronic prescription system: do the professionals use it?" *International Journal of Healthcare Technology and Management* 6(1): 32 - 55.
- Stokes, R. (2006). "Network-based strategy making for events tourism." *European Journal of Marketing* 40(5/6): 682-695.
- Suomi, R. (2005). Turning Finland to electronic personal taxation: an innovation adoption point of view. *COLLECTer LatAm 2005*, Talca, Chile.
- Susman, G. I. and R. D. Evered (1978). "An Assessment of the Scientific Merits of Action Research." *Administrative Science Quarterly* 23(4): 582-603.
- Thorelli, H. B. (1986). "Networks: Between Markets and Hierarchies." *Strategic Management Journal* 7(1): 37-52.
- Wassenaar, A. and S. Gregor (2001). E-business strategy formulating and forming: New wine in old bottles? *Global Co-Operation in the New Millennium The 9th European Conference on Information Systems Bled, Slovenia, June 27-29, 2001*.
- Wilkinson, I. (2001). "A History of Network and Channels Thinking in Marketing in the 20th Century." *Australasian Marketing Journal* 9(2): 23-52.
- Williams, T. (1997). "Interorganisational Information Systems: issues affecting interorganizational cooperation." *ELSEVIER, Journal of Strategic Information Systems* 6(3): 231-250.
- Williamson, O. E. (1985). *The Economic Institutions of Capitalism. Firms, Markets, Relational Constructing.*, The Free Press.

An enhanced communication model

Per Flensburg
University West
per.flensburg@hv.se

Abstract. The concept of information is often taken for more or less granted in research about information systems. This paper introduce a model starting with Shannon and Weaver's data transmission model and ends with knowledge transfer between individual persons. The model is in fact an enhanced communication model giving a framework for discussing problems in the communication process. A specific feature of the model is the aim for providing design guidelines in designing the communication process. The article ends with identifying a need for develop the model further to incorporate also communication within and between organisations of different kinds.

Keywords. information, communication, communication model, knowledge.

Introduction

To quote a famous Swedish Informatics professor: "Already in the sixties I realised that data and information was different!" The professor I refer to is of course Börje Langefors and it was he who actually triggered my interest in this area. However, at that time I did not agree with the Famous Icon! I claimed that Börje was talking about knowledge and not about information; that he made no distinction between them. However, as young Ph D student, my remarks was of little interest. But in my teaching I developed a model of data, information and knowledge and several hundred Swedish students have more or less willingly tried to understand it. When I in the early 2000 began thinking about network economy and systems integration the model was refined with something I called

“content” Preparing for HCC7 in sep 2006 I saw the similarities between my ideas about data, information, content and knowledge and the communication process. I presented the main idea at the conference – it was not in the proceedings – and many people liked it. So, here it comes. Enjoy!

The problem of transferring knowledge between humans

Shannon and Weaver (Shannon and Weaver, 1949) introduced their model of a communication system in 1949 (fig 1). This is however, a model of signal processing. They did not address the question of the content that was transferred, they only proved that it can be described as transfer of a bitstream.

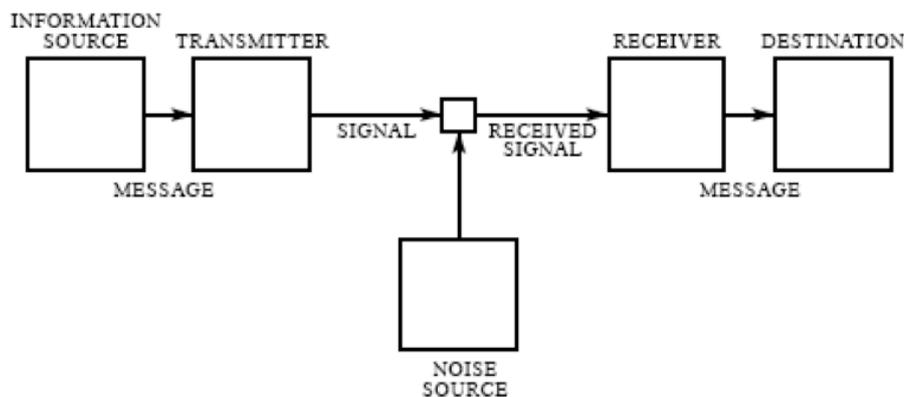


Fig. 1 – Schematic diagram of a general communication system.

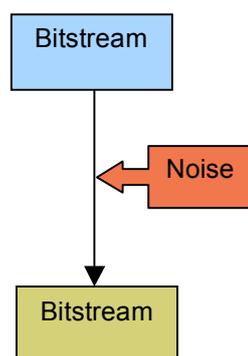


Fig 2: Bitstream

In this paper I will develop Shannon's model further up to knowledge transfer and then, from a theoretical perspective address the question of knowledge transfer between organisations. So let us start our discussion by simplifying Shannon's model as it is seen to the left. A **bitstream** is transferred and there are some noise coming in. Shannon showed that corrections can be done using redundancy and by calculating checksums. By using the appropriate checksum algorithm we can even correct the transfer and thus be sure the send bitstream corresponds to the received. But Shannon does not say anything about the content; about *what* is transferred.

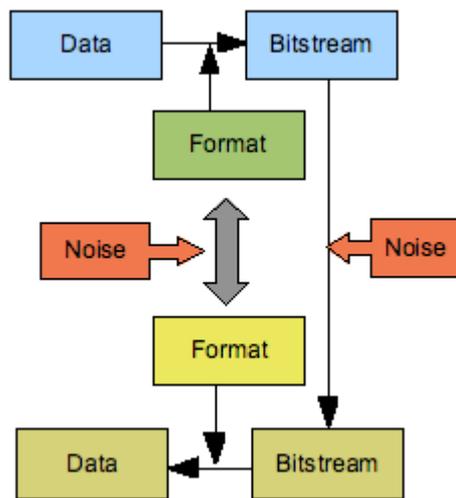


Fig 3: Data

Anyone who has dealt with data transmission knows that you have to know something about the format and type of **data** that are to be transferred. First you have to know if it is data or a program. If it is a program you have to know if the transfer is binary or hexadecimal and later on of course, if it is a program for a PC, Mac or Linux-computer. If it is data you transfer, you must know something about the type (text, picture, audio, video or something else). For each type you must know exactly what type it is (7-bits ASCII-text, JPEG-picture, mp3-file or a divX-movie

etc.). In short, you have to know the **format** of the bitstream in order to put the 1:s and 0:s together in a sensible way. The sender and the receiver must also have the same format. Technically you can execute a picture as a program, but the result is likely to be need for restart of the computer. Identity of the format is secured by using certain standardised format recognised by the file suffix. For instance a file with the suffix .jpg is to be treated as a picture in jpeg-format. In this case the noise (or rather insecurity) in the match of the format is reduced by heavy standardisation. So in short: **Bitstream + format = data** (fig 3)

Let us now for simplicity restrict our reasoning to text transfers. The principles can be applied for other types of transfers as well, but it is more simple to describe them for texts.

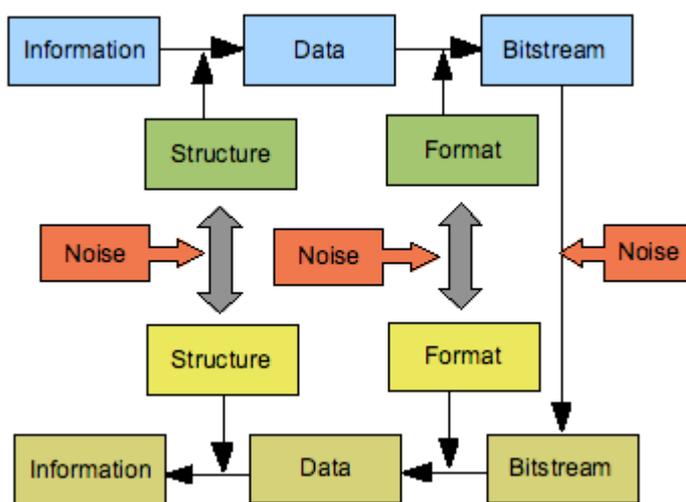


Fig 4: Information

Up to now we have transferred characters. In order for them to make sense we first have to put them together in words. We thus add **structure** in order to form words. The noise is reduced by using a specific vocabulary, that is a predefined set of allowed words. If we are transferring free text, we have principally all words in the actual language available. But

we have to say if it is a free text and in which language. If we transfer some more structured data, such for instance an instance of a database record, the vocabulary are considerably restricted, but on the other hand we can more efficiently secure the same data are transferred. In short: **Data + structure = Information** (fig 4).

In the case of transfer between two (or more) data bases the data can be seen as organised in tables and we have to know the headings in the columns in order for the transfer to succeed. The same goes for free text, we must put the words in correct order according to a grammar in order for the information to be interpreted in the intended way. We thus have to add **meta-data** in order for the information to be transformed to **content**, a concept I think is needed for introducing some ordered information. The noise in this case is reduced by explicit descriptions of the meta-data or use of a common everyday grammar. However it not possibly to ensure a perfect match, this is especially relevant for free text transfer. The grammar of our everyday language is not completely formalised; a lot of the meaning is implicit and have to be concluded from the text around. Redundant information as questioning and explanations might be also needed. So in short: **Information + Meta-data = Content.** (fig 5)

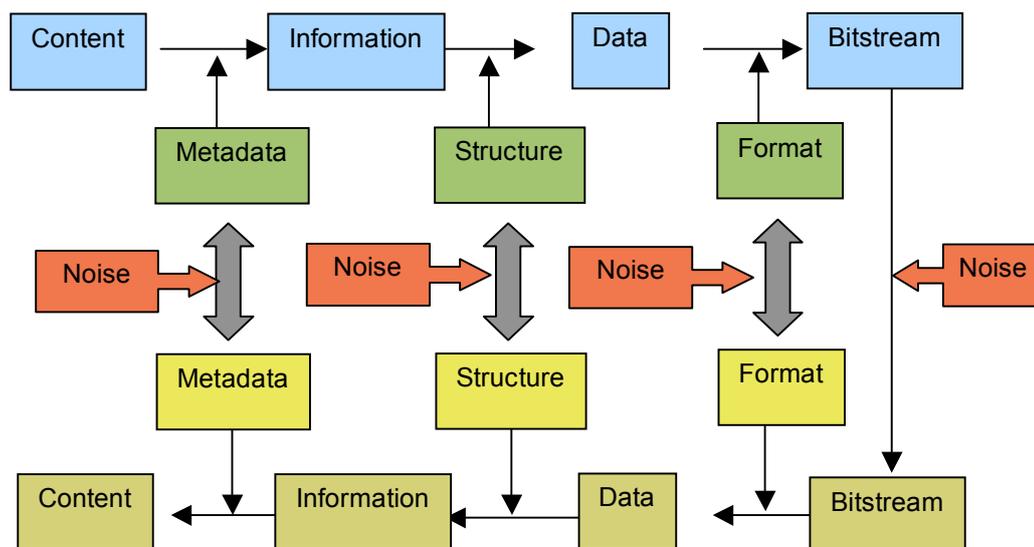


Fig 5: Content

Now we can proceed to the last step and talk about **knowledge** transfer. In order for the content to be possible to interpret as knowledge for a human being, a **context** is needed. The context provides the background for the humans to understand the meaning of the content. It is to be noted that only human beings can have knowledge. No humans have exactly the same context so much effort is needed in order to secure that the relevant context are the same. This is to be discussed later, but for now we note that everybody who has transcribed an interview, know that most of the time is used for ensure that the receiver has

interpreted the content in the intended way and they share the same context. In short: **Content + Context = Knowledge** (fig 6)

The concept “*knowledge transfer*” seems to be little odd at the first glance. It associates to something mechanical and not something human. One can ask what is the difference between “knowledge transfer” and “teaching”? Or “learning”? In my opinion, “knowledge transfer” is about the meaning of the content while “teaching” and “learning” is about the process of this transfer. “Teaching” and “learning” often have another purposes, you are supposed to change attitude, or opinion just by being taught. I will leave this process out of the scope of this paper, since there are numerous articles and books written about it and instead discuss the concept of “knowledge”.

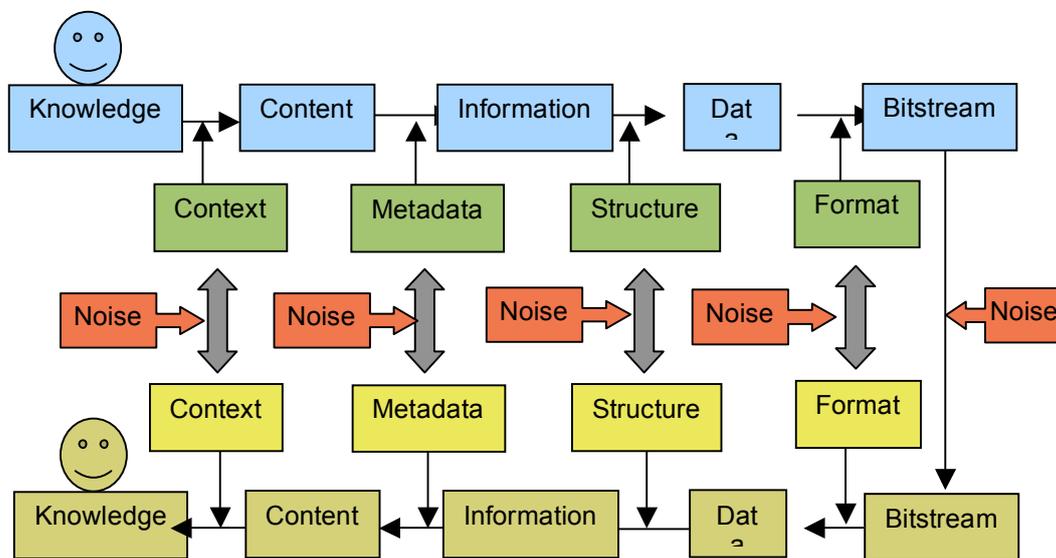


Fig 6: Knowledge

Knowledge

The difference between “content” and “knowledge” might be unclear and one might argue that “content” is also a type of knowledge. According to my definition “content” is achieved by adding meta-data to “information”. Thus, all what is needed is contained in this meta-data. But what is meta-data? Isn't meta-data also a kind of knowledge and does not meta-data require its own context? This is correct, but the context of the meta-data is a simpler context and partly formalised. Principally content can be transferred between computers, provided they have the same meta-data. However, this is not possible for knowledge, since it requires a creative act in the interpretation.

The model above deals with a specific type of knowledge, namely knowledge that can be expressed as content in a context. It does not deal with “skill” or “wisdom” or “tacit knowledge”. All these aspects seem however to be embedded in the context and when the context match and the content match, then we have a knowledge match. But how is this match achieved? At first glance it might seem almost impossible, since every human has his or her own context, made up of all our experiences during our lifetime. But experience shows it *is* possible for people to understand each other, it *is* possible to exchange knowledge. Despite the fact we have no exact match in context we have enough in common to create an understanding and thus knowledge. The word “create” is deliberately chosen, since I mean new knowledge is created when you understand something you did not understand before. That's why knowledge have something to do with creativity and as Churchman argues, creativity is an exclusive human behaviour (Churchman, 1971).

The key for understanding is thus to share enough context. If we study how people in practice talk to each other we see lots of efforts spend in order to make the other part understand. An exact transcript of an interview, reveals, as said before, how much redundancy is used and if the interview is also videotaped we see the body language add to this understanding. The aim is to achieve a shared context enough for understanding and the communication goes back and forth, since the speaker is usually very sensitive for the listeners reaction. Every lecturer with some experience knows when it is time for a break in the lecture room! So when we talk it is interaction and not only transfer.

In speech, the understanding is achieved by redundancy and by feed-back from the listener. But often speech is not possible and how is it then done? In traditional information systems we assume the system is the same and this assumption is often implicit, as Langefors points out in his elementary message (Langefors B, 1966). As long as we talk within one or two single companies it might work, but when we have a global information system, working in hundreds of companies and supporting a complex business process using hundreds of different systems, we can not rely upon one single system definition.

As indicated above, up to the level of “content” the transfer process is fairly formalised and in practice different versions of web-services is used. However, they assume all a common *ontology*, i.e. meaning of the concepts used. This is achieved by using standard ontologies and standard vocabularies. (Fensel et al., 2000). But it goes only up to the content level, when it comes to knowledge it is not enough. In modern e-business and other e-phenomenon, it is many times enough, since agreements have been made to follow a certain business process with predefined ontology (Schoening J, 2003). But in order to make a correct choice the user must know the meaning or in other words: Share the context of the business process to such an extent that knowledge is possible for him or her!

This is even more important when the process is not a business process but instead for instance a treatment process at a hospital or an issue in a public government. There the meta-data is hard to formalise and the result is often narrowminded bureaucracy leading to unacceptable results.

The problem now narrows down to: *How can people ensure they share the same context to such a degree that understanding is possible?* This is needed for the business processes (including public business) to be performed the intended way. I think *storytelling* is the answer. When we try to explain difficult things we often use an example, i.e. a story. When we read a good book, we get a view of the situation at that place and that time and create a context. But how can storytelling be used in businesses processes? How can the need for exact descriptions be satisfied in a fuzzy story? It can't, the story provides a background, a rich picture (Checkland, 1981) against which we interpret the content provided. The story needs also to be read and understood only once, since after that it is a known story. The idea is that when a person engages in a business process (n.b. including public business!) for the first time he or she reads the story behind the process and then hopefully understands the basic idea.

How is this story constructed? It should describe the activities in the process chain, it should describe items involved and it should describe complications that can occur and how these should be dealt with. All in a nice readable form! So new experts are needed: The business process storyteller, who tells the stories behind the process. This person must have the skill of a story-teller, be creative and also to some extent understand information systems and their role in the modern, networked organisations. But so far this expert has not been seen in reality.

Pros and cons with the model

The model is so far a theoretical construct. Further on, it provides a vocabulary for discussing certain issues about communication and is thus more like a tool for the scientist than for use in for instance practical systems development. The model is not operationalised, in fact I don't think that would be a good idea, since the power of the model is to provide a framework for discussions, not a fixed solution. The strength of the framework is the identification of several similar steps in the communication process which can be treated in a rather coherent way. However, this might lead to a believe that all steps are possible to formalise, which is not the case. I also think it is highly unbelievable that organisations employ a storyteller for telling stories about their business processes. Very few managers will have such a creativeness and boldness. In public processes such as in e-governance the transactions are much more complicated than the business

transactions covered in traditional business processes. Also the need for correct interpretation of a public business transaction can be a matter of life or death as for instance in the health care system. Thus a correct interpretation is essential.

Further research

So far I have only talked about knowledge transfer between single persons. But the context used in the presentation is business processes in both public and private companies. Hence, it would be interesting to enhance the model to cover also organisations and thus be able to discuss knowledge transfer between organisations. Since the model ends in story-telling and I claim story-telling is the way to transfer knowledge the model ought to be described in this way, as a story. Also the mechanisms of story-telling ought to be explored more. I guess literature science can provide some good ideas for this.

Other models

There are of course other models of communication available, both earlier than Shannon & Weaver and later. One of the earliest is Aristotles simple linear model. In his Rhetoric (Aristotle, 350 B C), Aristotle tells us that we must consider three elements in communication:

- * the speaker
- * the speech
- * the audience

It is a simple linear model and very obvious. In this paper I focus on the speech, but all three elements are tightly connected.

Another interesting model is the model of Laswell (Laswell H D, 1948) which is often described as in fig 7.

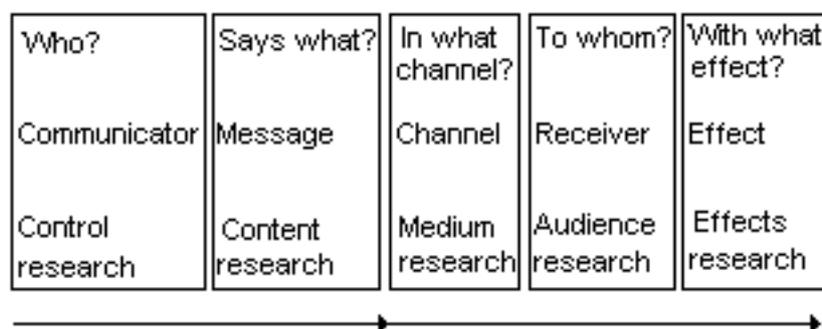


Fig. 7 Lasswell's model

It is to be noted that it was published before and had in accordance with Aristotle (Aristotle, 350 B C) its base in politics and mass communication. I have myself and unknowing of Laswell, developed a similar model for systems analysis and ontology generation, the Socrates model (Flensburg, 1988). It has also been used in a EU-project for ontology generation in the automotive industry (Flensburg P, 2004).

A more elaborated model is presented in (Berlo D, 1960). It is also a linear transmission model based upon the steps Source, Message, Channel and Receiver, but each step is more elaborated (fig 8). In fact, there are resemblances to the model I suggest, even some of the concepts are the same. However, Berlo does not distinguish between bitstream, data and information; they are all imbedded in the code. Further on, he does not introduce the concept of meta-data.

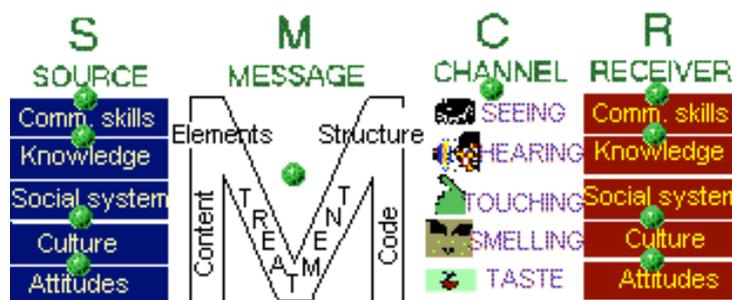


Fig 8. The model of Berlo

The transmission models have received critique for not taking the meaning, intention, context of the communication into account as well as the channel and the relations between the sender and receiver. Much of the critique can be traced to semiotics and similar linguistic approaches (Saussure de, 1971). Fish (Fish S, 1980), who is a literature scientist rejects the text's independence as a repository of meaning. He emphasizes that meaning is not inherent waiting to be 'transmitted' to more or less passive 'receivers'. Rather, the reader's active construction of meaning is so central that it might even be more accurate to speak of writing than of reading .

Berlo (Berlo D, 1960) also emphasise the meaning. In short he says:

- Meanings are in people
- Communication does not consist of the transmission of meanings, but of the transmission of messages
- Meanings are not in the message; they are in the message-users
- Words do not mean at all; only people mean
- People can have similar meanings only to the extent that they have had, or can anticipate having, similar experiences
- Meanings are never fixed; as experience changes, so meanings change
- No two people can have exactly the same meaning for anything

The models I have described so far are quite old, but they are well recognised within communication science. The main difference, as I perceive it, is my focus on *what* is communicated and their focus on the communication process. According to both Fish (ibid) and Berlo (ibid) the receiver has a great role, but I think also the sender has some responsibility to find a suitable form, structure and context in order to make the meaning of the message as easy to understand as possible.

References

- ARISTOTLE (350 B C) *Rethorics*, Athens.
- BERLO D (1960) *The Process of Communication*, New York, Holt, Rinehart and Winston Inc.
- CHECKLAND, P. (1981) *Systems thinking, systems practice*, London, John Wiley & sons.
- CHURCHMAN, C., W (1971) *Design of inquiring systems*, New York, Basic Books.
- FENSEL, D., HARMELEN, F., KLEIN, M. & AKKERMANS, H. (2000) *On-To-Knowledge: Ontology-based Tools for Knowledge Management*,.
- FISH S (1980) *Is There a Text in This Class?: The Authority of Interpretive Communities*, Cambridge, Mass., Harvard University Press
- FLENSBURG, P. (1988) *Systemutveckling med människan i centrum*, Lund, Studentlitteratur.
- FLENSBURG P (2004) Generation of ontologies for workflows. IN FLENSBURG P & IHLSTRÖM C (Eds.) *Learn IT, Know IT, Move IT – IRIS27*. Falkenberg.
- LANGFORS B (1966) *Theoretical Analysis of Information systems, I & II*, Lund, Studentlitteratur.
- LASWELL H D (1948) The structure and function of communication in society. IN L, B. (Ed.) *The communication of ideas*. Newyork, Harper.
- SAUSSURE DE, F. (1971) *Cours de Linguistique Générale*, Paris, Payot.
- SCHOENING J (2003) EEE P1600.1, Standard Upper Ontology Working Group (SUO WG), Home Page. IEEE.
- SHANNON, C. E. & WEAVER, W. (1949) *The mathematical theory of communication*, Urbana., University of Illinois Press.

Information Systems as a Medium for Identity Expression

Anders Henriksen

Phd student, Agder University College and Aalborg University

Anders.henriksen@hia.no

Abstract: Personalization is widespread in information systems. The feature brings elements of identity and identity expression to information systems. In this article we review and discuss different perspectives on identity and identity expression. We discuss personalization in the light of these terms and examine the use of the terms in information systems research. The article ends with a set of research questions on what type of identity are affected by personalization, how will users personalize in the light of identities and identity expression, how will personalization affect identities and identity expression in organizational contexts, and how will implicit and explicit personalization affect the user's identity and identity expression differently?

Keywords: Identity, Identity expression, Personalization, Information systems

Introduction

Identity and identity expression have been used to explain user behavior in several research fields. The approaches of these studies have been different, from expanding traditional behavior models like the theory of planned behavior (Conner and Armitage 1998, Manetti, Pierro and Livi 2002) to more comprehensive qualitative studies (Elsbach 2003, Blom 2003). Within information systems (IS) research on this “variable” has also got attention. Studies have found that identity expression has an influence on the usage of mobile services (Nysveen and Pedersen, 2005), changes the boundaries between

users and IT personnel (Gefen and Ridings, 2003), and contributes to increasing interactivity in communities (Ma and Agarwal, 2007).

Identity is used in everyday language. You buy garment and cars to express your identity. The discussion about identity started in 1600 by Locke, and has been followed up by philosophers ever since (Locke, 1975). Today they are not talking about one consistent identity, but that the identity changes over time and across situations. How is this identity constructed? Which identity is expressed at which situation? These are some of the questions about the concept of identity that have been discussed in the literature. In this article we will review some of the elements from these discussions. Another focus will also be how to express these identities and what an identity expression is. Blom (2003) is among the researchers in IS research that uses identity and identity expression to explain personalization behavior. Here, we discuss some of this work in order to put focus on some of the important issues studying identity and identity expression.

The aims of this study are threefold. First, we provide a short overview of the terms identity and identity expression, and see how these terms are used in the literature in order to contribute to a more general understanding of the terms. Second, we present personalization as a feature that enables information systems to express identities. This is done by reviewing and analyzing literature on personalization in several research fields. This will hopefully contribute to a broader understanding of personalization and its expression effects. Third, we present a set of research question associated with personalization, identity, and identity expression, in which we hope to contribute to a new research stream about personalization, identity and identity expression.

In the next section the term identity is discussed followed by a discussion about identity expression. The next section contains a discussion of the use of identity expression in Blom's research followed by a discussion about personalization in general. The conclusions from these to sections are then used to propose a set of research questions. Finally, a summary of this article is provided.

Identity

In the end of Bauman's (2004) essay on identity, he is asked a question about the use of Internet as a communication medium. The question focus on playing with identities and creating what they call "false identities" in communication with others on the Internet. It is several interesting elements in his answer, but here we focus on two major elements. The first element is identities in the "*fluid world*" (Bauman 2004, pp. 89). When Locke (1975) in the late 1600 focused on personal identity, he viewed identity as something continuous and homogeneous. You have one identity, often referred to as the biological identity, and this is lasting from as far as the individual's "*consciousness can be extended backwards to any*

past action or thought" (Locke 1975, pp 6) and throughout your whole life. The view on identity has changed over time and this is clearly shown in Bauman's (2004) essay. He means that committing to one identity your whole life or even for a long period is a risky project. Humans are consumers and identity is an object which is consumed. When compared to Locke this is a radical view, but Bauman (2004) means that as society has developed, creation and development of identities have acquired such a great focus that it may be considered a form of shopping. As Bauman (2004) expresses it: "*identity is for wearing and showing and not for storing and keeping*" (Bauman, 2004, pp 89).

The continuous change of identities discussed here can also be found in Bauman's (2004) metaphor about jig-saw puzzle identity creation. The reason why we bring this metaphor into our article is that it explains our ideas about identity creation. Bauman (2004) means that it is possible to compare identity creation with a defect jig-saw puzzle. In this defect jig-saw puzzle you either miss some pieces, have the wrong pieces or you are unfamiliar with the final picture. Solving a jig-saw puzzle is goal-oriented, you have a guarantee that all the pieces are available and you always know how far you have come and how much is left. When solving the identity puzzle you do not know if you have all the pieces and if those pieces you have available now are the right one. While Bauman (2004) means that a jig-saw puzzle is goal-oriented, the identity puzzle is tool oriented. Bauman (2004) suggests that solving the identity puzzle is not necessarily an end goal for contemporary individuals. This again reflects his view that having one identity for a lifetime is a risky project. Individuals do not want to create a consistent and coherent identity, but rather look at this as a limitation of freedom. Even though Bauman (2004) disagree with his own use of this metaphor, the processes occurring during the game illustrate how identity creation is performed, and therefore he uses it.

Identity theories

When Bauman (2004) discusses the contemporary identity question, he focuses less on what the identity of an individual consists of. Using Tajfel and Turner's (1979) social identity theory, which has later been developed into the self-categorization theory (Turner et al., 1987), we may better understand how identity is composed rather than created. This theory is based on a categorization of one's identities. As shown in figure 1, the biological identity is the baseline of the identity hierarchy, and can be viewed as the consistent part of an individual's identity. Above this identity is a set of identities categorized hierarchal.

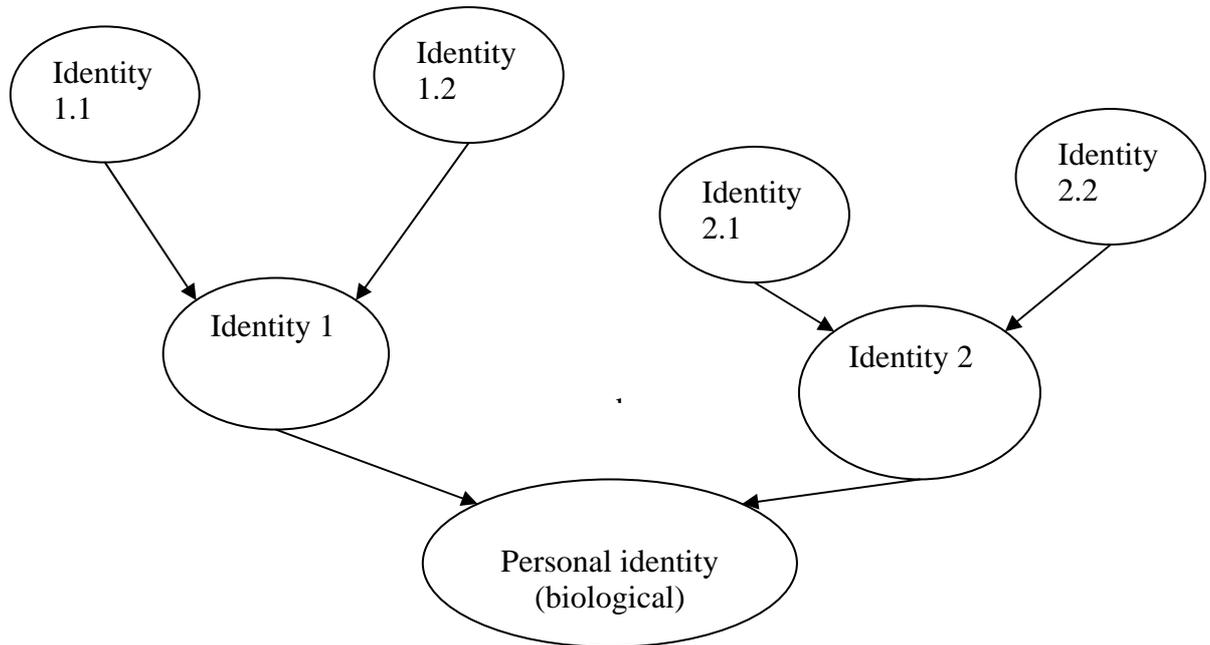


Figure 1 Simplified model of Tajfel and Turner's (1979) social identity theory. Identities are categorized and placed in a hierarchy, where the personal identity is placed at the bottom level (biological)

Which identity that is expressed at which time depends on the situation and where in the hierarchy the identity is. Let's look at an example. You are out with some friends for a beer, you meet a colleague, whom you usually have a professional relationship with. Together with your friends you usually express one identity and with your colleague another. You are not sure how to behave in this situation, but according to the theory you will express the identity which is highest in your identity hierarchy. This theory has a lot in common with Goffman's (1967) ideas about identities and self. The expression of an identity is dependent on the situation. Even though Goffman (1967) never explicitly discussed an inner consistent self, one may implicitly draw this conclusion from his ritual metaphor in which he says that the energy you get in a ritual is brought with you to your next ritual.

Another question is whether it is possible to separate personal and social identity. In many situations people use the term social and group identity, suggesting that a group has a common social or group identity (Keline et al. 1993). You create a common identity together with other people. But is this not another level in the identity hierarchy? In some social settings it is required that you "put on" a particular identity. But this identity will in some way have a connection to or be a part of your personal identity. It is not possible to

completely separate them. In different situations you can express different identities. A group is often associated with expressing specific identities, for example punks, business professionals etc. But these expressions will never be separated from the individual's personal identity. One should never say never in these settings, but generally social and personal identities are blurred. When Bauman (2004) says that keeping an identity throughout your whole life or in period of your life is a risky project, we suggest that Bauman (2004) means that you don't change your biological personal identity, but that identities higher in the identity hierarchy change over time.

Identity expression

We have now discussed identity and creation and building of identities. It is not possible to discuss identities without touching the expression of these identities, as we did in the last paragraph. But identity expression needs further explanation and discussion. Bauman (2004) focused on the expression of identities in his essay. He discussed the use of artifacts for identity expression, for example garment, cars, houses, mobile phones etc. We can here compare Bauman's (2004) view with Goffman's (1967) studies on interaction on micro level, in which all kind of expressions reflects self or identities to an individual, and the expressions are connected to the situation.

You change artifacts that before expressed one identity with new artifacts expressing new identity. Also other researchers in different research fields have discussed the use of artifacts as expression of identities. Elsbach (2003) studied the use of artifacts to express workplace identities, Taylor and Harper (2001) studied the use of mobile phones as an artifact for expressing identities, and Belk (1988) studied products consumed to express identities. This focus on artifacts expressing identities has created a market for products that are adjustable to individuals' identities and individuals' emotional states. These forms of adjustments are often referred to as personalization.

Identity expression in IS

In Baumann's (2004) second element in his discussion about communication on Internet he focuses on expression of identity in communication through mobile phones and Internet. In our fluid world, where individuals turn around their identities, electronic equipments are useful (Bauman 2004). Bauman (2004) means that we use these electronic equipments as an easier way of building social safety net. Individuals do not need to take into considerations every aspect of a face to face communication. Bauman (2004) discusses that individuals replace the traditional social network where intimacy and nearness are important with new less complicated networks. By looking at Goffmann's (1967) studies on

interactions, at all the phases in a face to face interaction, all the choices, and the outcomes, we can see what Bauman (2004) means when he suggests that electronic communication replaces a more complex face to face communication. Bauman (2004) means that the fluid world has pushed the needs of these communication media, and not that the technology has changed the communication pattern.

But, it is not just in individual to individual interaction with the use of mobile and Internet that identity expression has been studied. Identity expression is also often used in behavior studies explaining the use of information systems and mobile services (Nysveen and Pedersen, 2004; Nysveen et al., 2005; Lin and Wu, 2002; Greer and Murtaza, 2003, Gefen and Ridings, 2003). The term is applied in different ways, and the same researcher can use the term differently in different studies. To illustrate this, we have reviewed the use of identity expression by a researcher. We have collected his articles and studied his use of identity expression. We have chosen the researcher Jan Blom, a Finnish researcher at the Nokia research centre. His doctoral thesis, titled “Psychological complication with personalization of user interface”, studied personalization of mobile phones and Internet portals. We have selected articles published both during and after his doctoral thesis.

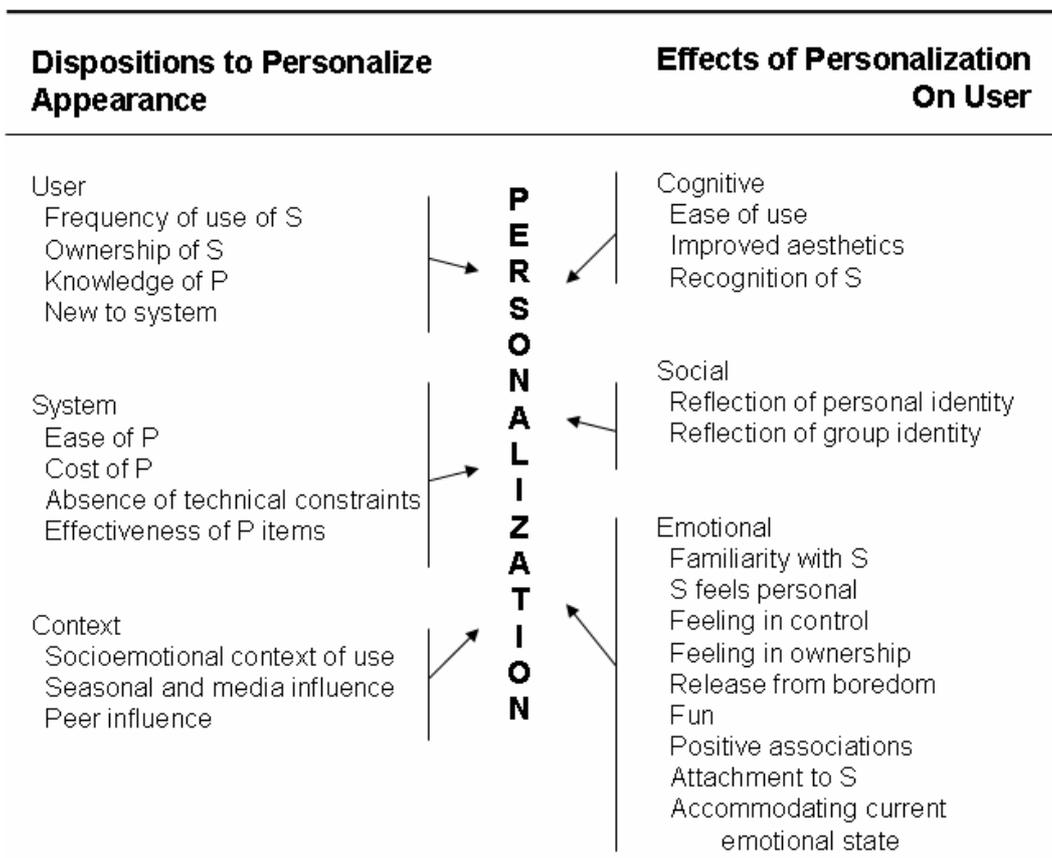
In his first article, in which he presents taxonomy for personalization, he uses the term identity expression (Blom, 2000). In this article he uses it with reference to Goffmann’s (1959) book “The presentation of self in everyday life” and in a setting in which he discusses identity expression as one of the dispositions to personalize the appearance of a PC or a mobile phone. He also discusses personality, but without any reference to identity. In addition to identity expression he uses the term self-presentation. Both personality and self-presentation can in the literature be connected to identity expression (Nysveen et al, 2005 and Lamb and Kling, 2003). With the use of Goffmann’s (1959) reference he studies the use of products as expression-artifacts used by individuals performing a specific task. Further, he pinpoint that the group an individual associate him/her self with, is an important part of the individual’s identity. Example he uses here is:

“a peer group might be attaching stickers to their phones in order to identify themselves with that particular group” (Blom, 2000, p.313)

In his next article Blom presents the theory of personalized recommendations (Blom, 2002). In this article he focuses less on identity expression, but comments that recommendations are based on an individual’s preferences and that this may help creating a self-picture through the individual’s identities. The next article from Blom is the “Theory of personalization of appearance: why people personalize their mobile phones and PC’s” (Blom, 2003). When he in this article uses identity expression he again refers to Goffman (1959). He now presents a definition of identity expression:

“Identity expression is to express identity to one self or others” (Blom, 2003, p. 196)

He suggests that personalization of appearance is an effective way of expressing the user’s identity, in which he views as one of the dispositions to personalize. Blom found that personalization was *“often compared to the use of clothes as a way to distinguish oneself from others”* (Blom 2003, pp. 204). Here Blom separates personal and group identity expression. The latter he connects to personalization increasing group connection by performing the personalization together, or performing the same personalization (use the same sticker on the mobile phone). Blom (2003) also found that through personalization the feeling of being in control increased by expressing the individual’s identity. In his theory he identifies a set of dispositions to personalize and a set of effects of personalization. Blom (2003) presents his theory in a model represented in Figure 2.



Note. S = system or product, P = personalization

Figure 2 Theory of personalization of appearance (Blom, 2003)

As the model in figure 2 shows, Blom (2003) means that the reflection of personal and group identity is an effect of personalization. To get a better insight

in how Blom (2003) has reached these conclusions, and what he puts in the terms, a further study of his data and applied method is required. Blom (2003) used grounded theory with reference to Strauss and Corbin (1990). In grounded theory both the theory and analyzes are close connected to the data. Grounded theory is a method to develop theory in which the empirical data is the baseline. Blom (2003) used three studies in which he in two of them arranged focus group discussions about personalization. Analyzes of these group discussions were the baseline of his theory. In the article he presents several expressions from these discussions to illustrate the different categories in his theory. We will represent some of these expressions related to identity expression to illustrate how Blom uses the term.

Personal identity:

“Everyone wants to see an identity, their own identity, have this stuff identified. This is mine cause it’s got that on it, its look like that” (Blom, 2003, p. 227)

Group identity

“My best friend sent me a “Barbie girl” theme tune cause I’m dizzy. So I had that as my ringing tone for quite a while. Quite a good talking point, “why do you got that?”” (Blom, 2003, p.227)

Blom uses this theory and the taxonomy in a new study on the use of a mobile service (Blom et al., 2005). In this study Blom et al. (2005) again uses the term identity expression. The term is now used as a set of information (in the form of text and pictures) which represents the user (an individual) of a mobile service. The user fills in information about him/her self from a set of predefined categories. This can be name, age, addresses, favorite food etc. This identity expression (as Blom et al. 2005 calls it) is visible to other users of the system. The users can, based on this identity expression, decide to communicate with each other through the mobile service. In the article, identity expression is used as a term for the profile the user generates.

We have seen that from the first article where Blom presented the term identity expression until the last one, the meaning of the term has changed. In the beginning he bases the term on Goffman’s (1957) interactionism, while he in the last article uses an instrumentation of the term connected to set of attributes (pre defined) distributed through a mobile service. The term identity expression has moved from being floating and normative with a set of “soft” data, to be more concrete and connected to a set of “hard” data.

Personalization

So far in this article the terms identity and identity expression have been discussed. We have also seen Blom’s use of the term identity expression in

combination with personalization. We now want to look further into the phenomena personalization.

To clarify what we mean when we use the term personalization, we want to use the definition provided by Blom (2000).

"A process that changes the functionality, interface, information content, or distinctiveness of a system to increase its personal relevance to an individual" (Blom, 2000, p. 313)

This personalization process can be performed either by the user or by the system. In the research literature this is referred to as explicit or implicit personalization. In the next section we will discuss these two types in the light of the above discussions on identity and identity expression.

Explicit personalization

The explicit personalization process is performed by the user it self. The user is able to change the content, interface, or the functionality of the system. Performing explicit personalization requires several personal choices. What information is important for me, how does I want it presented, how does I want the functionality to be, and how should the system distinctive from others? With this we do not mean that every personalization process involves all these choices, but at least one of them will be present. Tafarodi et al. (2002) studied choice and personalization of literature tasks. They let individuals perform specific tasks, in which they controlled the individuals' ability to personalize. They found that the personalization of a task increased perceived control of the task, increased the motivation of performing the task, and found partly support that personalization increased the performance of the task. They also pointed out that to get a better understanding of the effects of choice, the identity expression must be visualized and discussed (Tafarodi et al. 2002). In the Tafarodi et al. (2002) study all personalization were performed explicitly.

Implicit personalization

In implicit personalization the process is performed by the system. The research literature divides this personalization form into three main groups. We will give a short description of these three, but for further information it is recommended to read the following articles: "A framework for classifying personalization scheme used on e-Commerce Websites" (Wu et al. 2002) or "Personalization and customization: A strategic leverage to sustain e-trading market share" (Liu et al. 2005). The three groups are:

1. Profile / group based personalization
 - a. The personalization is based on a profile given by the individual, or based on a group / role that the individual is a part of.
2. Behavior based personalization

- a. The personalization is based on earlier click-streams or other user behavior.
3. Collaborative based personalization
 - a. The personalization is based on other users' behavior.

In implicit personalization the system performs the personalization for the individual. This personalization is based on information about the individual itself or from other individuals. Is it then possible to express identities through a system? Can information systems express identities for the individual? To answer these questions we will first focus on a study by Saari and Turpeinen (2004). In their study they present a framework for personalization. It is not the framework itself that is interesting, but their approach to implicit personalization. They discuss emotional and cognitive effects of personalization. They suggest that by giving individuals personalized information in the way that it gives emotional and cognitive effects, it will stimulate individuals to make better and faster decisions and be able to better recognize products. The psychological personalization can be based on personalized profiles, behavior, and psychological instruments (Saari and Turpeinen, 2004). The psychological instruments register eye movements, pulse, and its indexes. By combining the eye movements and pulse registrations it is possible to get a fine grained analysis of the relationship between the information, the visual elements the individual are presented for, and the psychological response (Saari and Turpeinen, 2004). Saari and Turpeinen (2004) suggest that by combining these data with the individual's behavior and registered profile it is possible to present information adjusted to the individual's identity, and the individual's emotional and cognitive state. Saari and Turpeinen (2004) discuss many areas in which these kind of personalization strategies can be used: telemedicine, military command and control systems, games, and e-procurement. This approach to personalization is an example of how an information system with implicit personalization can express identities for the individual. But do information systems need to have these kinds of extreme personalization techniques to express the individual's identity? Implicit personalization is in most cases based on gathering information about the individual, and based on this adjust the system's information, functionality and/or user-interface to the individual. When this adjustment is done the information will in some way express the individual's identity.

Research questions

Based on the above discussion we will in this section present a set of research questions.

In Blom's research the usage of the term identity expression gradually changes, from a wide definition based on interactionism to specific elements about an individual's identities. From Blom's studies there seem to be limitations in the expression effect made possible by personalization. Blom (2005) suggested specific parts or kinds of the individuals' identity were expressed through personalizing their mobile services. This raises the following research question:

RQ1: What kinds of identities are affected by personalization?

If we look at the self-categorization theory (Turner et al., 1987), it is likely that identities higher in the identity hierarchy will be affected by personalization, even though elements from the biological identity also will be expressed through the system. We have discussed the differences between social and personal identity earlier in this article, but we suggests that an important issue in this research question will focus on the expression of personal and social part of the individuals' identity.

Tafarodi et al. (2002) studied the effects personalization had on literature tasks. They suggested that identity expression is one of the major parts that need to be examined when studying personalization. The choices that the individual has to make during the personalization process of an information system may be made to express parts of the individual's identity. Blom also found that a system needed "*to be effective of their ability to express the identity of the user*"(Blom, 2002, pp 202). Thus, the following research question is posed:

RQ2: How will users personalize in the light of identities and identity expressions?

Blom (2003) found in his study that individuals personalized together, or executed the same personalization. The motivation behind this form of personalization was to express a common group or social identity. To personalize in the light of identities will in some way be like shopping of identities, as Bauman (2004) expresses it. The personalization process will be like buying an artefact to express a certain identity.

Elsbach (2003) studied the introduction of non-territorial office spaces in an organization, in which she focused on identity and identity expression. She found that by removing the possibility to personalize the employee's office spaces, several identities were threatened. The employees had no longer the possibility to express their identity through artifacts as they did before. She also observed that the group connections were weakening. Elsbach (2003) also registered that this threatening of identities lead to another way of acting. The employees expressed their identities in other ways. Threatened identities will also be present in large

global organizations, particularly when introducing information systems. Individuals may no longer communicate face-to-face with their colleagues. With the use of implicit personalization individuals can strengthen group connections through the information system instead. Individuals can identify themselves with the information system and the group that they belong to. The information system expresses some of the individual's identity. Thus, we propose the following research question:

RQ3: How will personalization affect identities and identity expression in organizational context?

Elsbach (2003) found that expression of identities is important in an organizational context. Individuals need to express their workplace identity. Elsbach found that personalization, or the lack of personalization, affected the individuals' identities. One often used personalization technique inside an organization is role based implicit personalization, and we suggest that in RQ3 issues regarding implicit personalization and identity expression will be relevant.

Blom studied both implicit and explicit personalization (Blom, 2003, 2002). His theory of personalization of appearance (Blom 2003) is based on explicit personalization, while his theory of recommendations is based on implicit personalization. As discussed above he uses and discusses identity expression as both a disposition and an effect of personalization of appearance, but he does not focus on identity expression in his theory of recommendations. But as we have discussed above, implicit personalization will also enable identity expression. These differences between the personalization approaches make us raise the following research question:

RQ4: How will implicit and explicit personalization affect the user's identity and identity expression differently?

Without explicitly discussing it, Blom's studies shows that implicit and explicit personalization will affect the individual differently. Tafarodi et al. (2002) found that personalization of literature tasks increased perceived control, motivation and performance, but they did not discuss the effects it had on identity and identity expression. It is likely to assume that implicit and explicit personalization will affect different identities in the individuals' identity hierarchy.

Summary

In the beginning of the section about identity we presented the metaphor about jig-saw puzzle and used it about the creation of identities. This jig-saw puzzle is a game where there is no final goal and the pieces are created while playing. Through the discussion of different type of personalization we have shown different ways of how information systems may express individuals' identity and how individuals may express their identity through the systems. Information systems are thereby pieces in the identity jig-saw puzzle, in which it on the one side operates as an artifact on the same level as clothes, cars and mobile phones and on the other side as a jig-saw puzzle player. With the combination of explicit and implicit personalization information systems may not only be a medium for expressing identity, but it will also express the identity for the individual. In the fluid world the term identity has change from the early interpretation that an identity was consistent and lasted for a life time to shopping of identities. Identities are now being referred to as objects you can consume, and the use of artifact to express identities are as common as buying a car. The society has forced individuals to communicate and create networks in other ways, with the help of mobile and Internet communication. It is not only private that the demand for an identity exists, but also inside organizations. This has made the request for personalization of information systems.

We have through the article discussed and presented an overview of the terms identity and identity expression. We have seen how these terms are used in applied IS research. We have also discussed personalization and presented this as an information system feature enabling identity expression. We have also presented a set of research questions based on our discussions enabling further research on the topics personalization, identity and identity expression. With this we hope to contribute to a more general understanding of the terms and to a further research stream within the IS field.

Reference:

- Bauman, Z. (2004) *Identity. Conversation with Benedetto Vecchi*, Polity Press
- Belk, R.W. (1988) "Possessions and the extended self". *Journal of Consumer Research*, vol. 15, 139-168.
- Blom, J. (2000) "Personalization – a taxonomy", *Extended abstracts of the HCI 2000 conference on human factors in computing systems Seattle*, 313 – 314.
- Blom, J. (2002) "Theory of Personalization recommendations", *Extended abstracts of the HCI 2000 conference on human factors in computing systems Seattle*, 540 – 541.
- Blom, J. and Monk, A. (2003) "Theory of personalization of appearance: why people personalize their mobile phones and PCs," *Human-Computer Interaction*, vol.18, no.3, 193 – 228.
- Blom, J., Persson, P., and Jung, Y. (2005) "DigiDress: A field Trail of an Expressive Social Proximity Applixation", *Springer-Verlag Berlin Heidelberg*, 195 – 212

- Conner, M., and Armitage, J.C. (1998) "Extending theory of planned behavior: A review and avenues for further research" *Journal of Applied Social Psychology*, vol 28, nr 15, 1429-1464.
- Elsbach, K.D. (2003) "Relating physical environment to self-categorizations: Identity threat and affirmation in a non-territorial office space," *Administrative Science Quarterly*, vol. 48, 622-654.
- Gefen, D., and Ridings, C.M. (2003) "IT acceptance: Managing user – IT group boundaries," *The DATA BASE for Advances in Information Systems*, vol. 34, no. 3, 25-40
- Goffman, E. (1959). *The presentation of self in everyday life*, Doubleday, Garden City, NY
- Goffman, E. (1967). *Interaction ritual, essays on face-to-face behavior*, Anchor Books
- Greer T.H., and Murtaza M.B. (2003) "Web personalization: The impact of perceived innovation characteristics on the intention to use personalization", *Journal of Computer Information Systems*, 50 – 55.
- Kleine, R.E, Kleine, S.S., and Kernan, J.B. (1993) "Mundane Consumption and the Self: A social identity perspective" *Journal of consumer psychology*, vol. 2, nr, 3, 209 – 235
- Lamb R., and Kling R. (2003) "Reconceptualizing Users As Social Actors In Information Systems Research" *MIS Quarterly*, vol. 27, no. 2, 197-235.
- Locke J. (1975) "An Essay Concerning Human Understanding" *Oxford: Clarendon, Book II*
- Lin, S.C., and Wu, S. (2002) "Exploring the impact of online services quality on portal site usage," *Proceedings of the 35th Hawaii International Conference on System Science Hawaii*
- Liu, J., Fisher, S., and Peters, S. (2002) "Personalization and customization: A strategic leverage to sustain e-trading market share," *Proceedings of the 7th International Enterprise Information Conference*, 40-47.
- Ma, M., and Agarwal, R. (2007) "Through a Glass Darkly: Information Technology Design, Identity Verification, and Knowledge Contribution in Online Communities" *Information Systems Research*, vol. 18, no. 1, 42 - 67
- Mannetti, L., Pierro, A., and Livi, S. (2002) "Explaining consumer conduct: From planned to self-expressive behavior," *Journal of Applied Social Psychology*, vol. 32, no. 7, 1431-1451.
- Nysveen, H., and Pedersen, P.E. (2004) "An exploratory study of customers' perception of company websites offering various interactive applications: moderating effects of customers' Internet experience," *Decision Support Systems*, vol. 37, 137-150.
- Nysveen, H., Pedersen, P.E., and Thorbjørnsen, H. (2005) "Intentions to Use Mobile Services: Antecedents and Cross-Service Comparisons" *Journal of the Academy of Marketing Science*, vol. 33, no. 3, 1-17.
- Saari, T. and Turpeinen. M, (2004) "Towards psychological customization of information for individuals and social groups", *Human-Computer interaction series, 5, Designing personalized user experiences in eCommerce, Kluwer Academic Publisher*, 19 – 37
- Strauss, A., and Corbin, J. (1990). *Basics of qualitative research*, Sage, London
- Tafarodi, R.W., Mehranvar, S., Pantou, R.L.M and Milne, A.B. (2002) "Putting oneself in the task: Choice, personalization, and confidence," *Society for Personality and Social Psychology*, vol. 28, no. 5, 648-658.
- Taylor A.S. and Harper, R. (2001) "Talking activity: young people and mobile phones." *Presented at the CHI 2001 Workshop on mobile communications, Seattle, WA*
- Tjafel, H., and Turner, J.C. (1979) "An integrative theory of intergroup conflict," *The Social Psychology of Intergroup Relations*, 33-47.
- Turner, J.C., Hogg, M.A., Oakes, P., Reicher, S.D. and Wetherell, M. (1987) "Rediscovering the social group: A self categorization theory". Oxford: Blackwell,

Wu D., Im I., Tremaine M., Instone K., and Murray Turoff. (2002) "A framework for classifying personalization scheme used on e-Commerce Websites", *Proceedings of the 36th Hawaii International Conference on System Science*

High school students - Relationship between ICT and psychosocial life environment

Ulrika Danielsson

Department of Information Technology and Media

Mid Sweden University

Ulrika.danielsson@miun.se

Abstract. Research concerning the use of computers and changes in work life and work environment has been carried out in Sweden for more than 30 years, but so far very little of the experience and conclusions from these research results have been applied in the schools. This paper present a study which purpose was to find relationship between ICT and the life roles and the life environment of students in the occupational group "IT-high school students" in Sweden. The results of the case show that the mobile phone was turned on 24 hours a day - seven days a week, because the students wanted to be easily reached by friends and family, and that the students failed to notice that their schoolwork and leisure interests were virtually one and the same. This case study provides a deeper understanding concerning work life among students, were similarly results already have been seen in the regular business world. Further analysis of these results should be presented in two separate papers, one paper to be focused on the life role and the other focused on the life environment, and it would also be revealing to conduct a larger study.

Keywords. ICT, students, work, leisure, role, boundary, life environment

Introduction

Research concerning the use of computers and changes in work life and work environment has been carried out in Sweden for more than 30 years. A major step

concerning research in the area of work life and work environment was taken during the 1970's when an increase in leisure was widely predicted as a consequence of developments in technology. Contrary to the prediction, it is now obvious that *work* appears to be squeezing out *leisure* in many contexts (Lewis, 2003; Taylor, 2002). And since the end of 1970 there has been an interest in changes in work roles and the psychosocial work environment in interaction with ICT (Information Communication Technology) (e.g. Allwood, 1991, Aronsson & Dallner, 1994, Bradley, 1986, Frankenhaeuser and Ödman, 1987, Lennerlöf, 1991). By the end of the 1990's, interest in these changes expanded as the computer was introduced in the schools, from pre-school to university. Research in the field of computer use in schools increased by the end of the 1990's (e.g. Bergman, 1999, Danielsson, 1999, Edström & Riis, 1997, Jedeskog, 1994, Pedersen, 1998, Riis & Jedeskog, 1997.)

In the beginning early in 2000 there was an increased interest in work life and its changes due to ICT. Research was conducted on the increased usage of ICT both at work and in the home environment. Several studies were conducted regarding the connection between ICT-usage and the psychosocial work environment, with focus on the positive and negative effects on humans' behavior and health (e.g. Allvin *et al.* 1999, Bradley, 2001, Hansson, 2004, Sandberg and Augustsson, 2002, Åborg, 2002), but so far very little of the experience and conclusions from these research results have been applied in the schools (Danielsson, 1999, Danielsson & Danielsson, 2005). Research concerning work environment in schools, with focus on the students' life role, has slipped out of focus. Research is primarily focused on the school system, giving a historical perspective of teachers' health, work, and professional role (e.g. Carlsson *et al.*, 2004), though some studies have been focusing on students work conditions arising from extensive use of the portable computer (Isaksson *et al.*, 2003).

Hence, referring to the research of today in this area, it has been relatively little explicit focus on the work-leisure interface, especially concerning young people in compulsory grade school and high school. Studies have either focused on home use or school use of ICT, but not many of the studies have made detailed comparisons between the two environments, and few studies have sought children's own descriptions about their experiences and need for boundaries between (school) work and leisure, and between the private versus the professional role. I will address the effect of the experience of ICT on students' life role and life environment in the home and the school and in that way offer guidance to our students for future working life.

Structure of this paper

The paper is outlined as follows: first, the aim and method of the case study is presented. Secondly, background theories of psychosocial life environment and the life roles in interaction with daily use of ICT are outlined, followed by earlier

work performed by the author of this paper. Finally, results from the case study are presented, continued by a discussion of the results in relation to theories and by identification of characteristics among the group "IT-high school students".

Purpose

The aim of the case study "IT- High school students" is to find a relationship between ICT and the life roles and the life environment of students in the occupational group "high school students" at a typical IT-high school in Sweden.

Method of the case study

Instrument

The empirical survey is based on semi-structured interviews (Kvale, 1997) performed during one week (7 -10 November) in 2005. The interviews lasted about 40 to 60 minutes each and took place in a study room at the selected high school. All the answers were recorded and treated anonymously (Repstad 1988, Holme & Solvang 1991).

The method and the questionnaire were the same as during the interviews with "Young urban knowledge people" (Danielsson, 2002). The questionnaire was based on Bradley's model: Relationship between computer technology, work environment and stress (see fig 1). The attempt was to collect information concerning peoples; Objective environment and Subjective environment (over stimulation and under stimulation) (ibid).

Participants

The survey group is defined as "IT- High school students," in other words, high school students that by virtue of personal interest were attending a high school with IT emphasis in all the major subjects. Each student had his/her own computer. The student interviewees totaled 10 persons, five women and five men, between the ages of 18 and 20. All the students were chosen from the same school, an IT-high school in Sweden where they were enrolled in an "IT-media program". They all attended to the same class during their senior year. There were a number of reasons for selecting this particular school: First, the school had an approved IT emphasis comparable to ordinary high schools in Sweden; second, this school was located in the county of Jämtland where three earlier studies had been performed concerning the launch of IT in the schools' environment (Angland and Danielsson, 1996, 1997, Danielsson, 1998, Danielsson, 1999). The school was also within a reasonable distance from my office so I could visit the school and perform interweaves during one week, limited only by the time the students could be present.

Criteria for the students selected for an interview:

- The student must be attending the high school with a major in the IT-field;
- Personal interest in the IT-field;
- 17 to 20 years old, attending his/her senior year at high school;
- Had no children;
- Must live together with parents or in a single household during the school weeks;
- The student should be interested in the problem area of the study and should be open to answering questions about his/her life role;
- 10 people were included: 5 women and 5 men.

Interaction between ICT and psychosocial life environment

The amount of implemented ICT in work and education contexts continues to increase. In light of the present transformation of society, the type of skill a person has becomes the most prominent to employment. The demands are flexibility and expertise within different fields, the ability to use innovative thinking and the ability to explore new ways of working. The expressions 'lack of time' and 'time pressure' indicate an ever-quickening pace of work and a greater demand on the individual and the group to become more efficient and available, both locally and globally, through, for example, the mobile phone and e-mail. The changes occurring in work life described by Castells (1998) are as tremendous as the changes that occurred during the industrialization that took place during the last century; and the changes are very similar to each other. Wiberg (2005) describes the current transformation we see in society as a transformation from the Information society to the Interaction Society. This interaction society has formed new behaviors as well as new modes of availability, as with ICT where ways of interaction are possible at all times.

In the following section theories concerning life environment, life role and use of ICT will be presented.

Life environment

When preparing for this study, I acquainted myself with the theoretical models of Bradley, which show the relationships between computer technique and the psycho-social work environment where she also describes a constant interplay between objective and subjective work environments (fig 1). Since the work environment has both a physical and psychological side, it is of great importance

to assume a broad perspective of the work environment problems; one receives an overall picture of the connections between society, company and individual. There are numerous factors behind a person's stance and attitude to his/her work environment. These factors might for example be a difference of background, gender, age, needs, wishes, experience, and expectations. For an overall picture of life environment, I have included both the home environment and work environment of the interviewees. For purposes of this study, the students school work environment is the same as work environment.

The concepts in figure 1 gave a foundation for the questions that should be included in a study in order to achieve an understanding of a person's reaction concerning objective and subjective work environment. Furthermore, while analyzing the answers the results could be brought back and compared and controlled through the model in aim to discern different ways of ICT use that could affect a person's life environment.

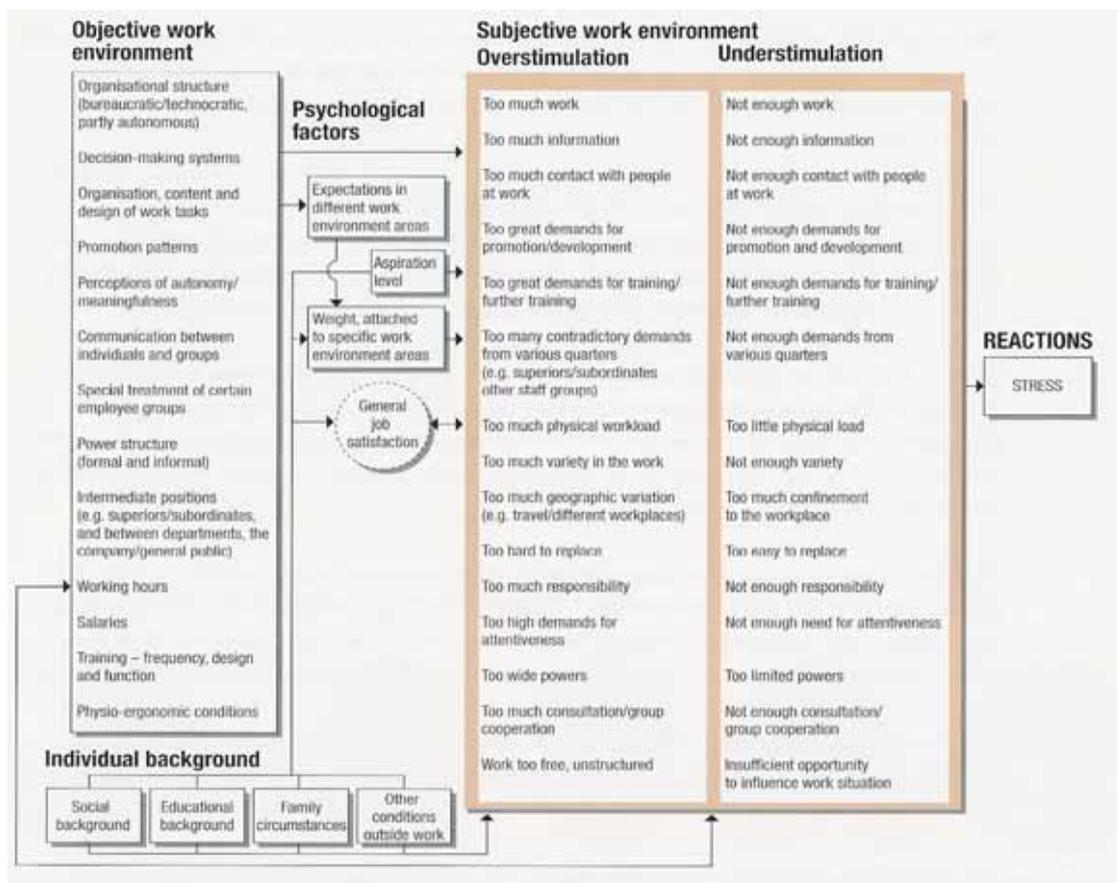


Figure 1. Relationships between computer technology, work environment and stress (Bradley 2001, p 37)

Life role

Every person fills a number of roles (daughter, student, neighbor), and these together constitute a life role. A person's life role can be divided into three major roles: the Private role, the Professional role, and the Citizen's role (Bradley 2001, Danielsson, 2002). To go deeper into the role-concept would be to discuss an individual's identity, but that is beyond the scope of this paper. That discussion has been made in an earlier paper where it was found that identities, especially among the young people, are fluid, complex and difficult to hold constant (Danielsson, 2000).

A short description of the other three roles and how these concepts will be applied in this paper is presented below.

- The Private role includes activities that refer to private life (the home as work environment and private environment, different services on the net, etc.);
- The Professional role includes activities that refer to work life (work content and different aspects of the psychosocial work environment, physical and virtual places for performing work, etc.);
- The Citizen role includes activities that refer to citizen life (to what extent do the IT-students of today take an active interest in societal issues, e.g., political issues, and are active within voluntary, non-profit organizations, etc.).

In an attempt to understand the complex interplay between ICT and life environment related to factors as for example values and norms, labor market and development of different technologies, I make use of Bradley's model of the interaction between ICT and the psychosocial life environment (fig 2). The model is a development expansion of the earlier model (fig 1) and show what areas that are conversing and interact.

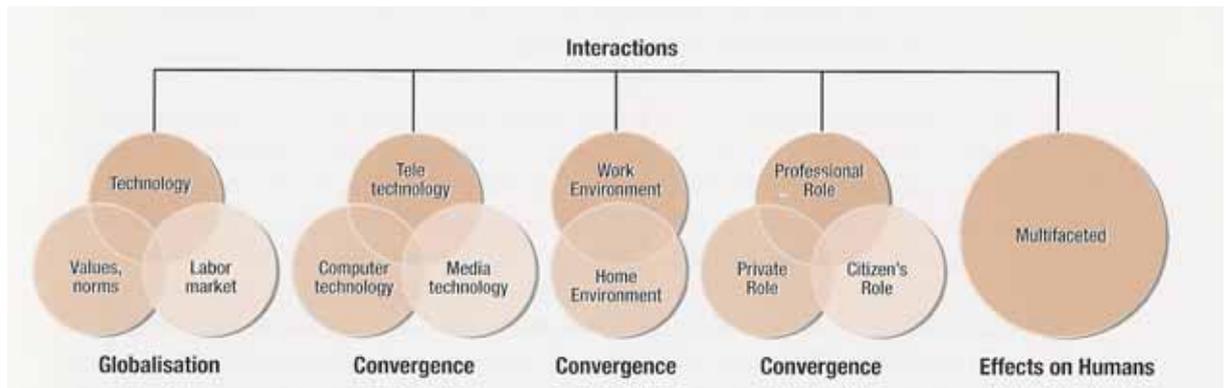


Figure 2. Theoretical model on the interaction between information and communication technology (ICT) and psychosocial life environment (Bradley, 2001, p 39)

Some comments:

- Work Environment and Home Environment are converging to become Life Environment.
- Professional Role, Private Role and Citizen's Role are also converging.

On the basis of this model, I have developed the questionnaire concerning the study to analyze IT-high school students' different roles, in order to understand if and how they might converge into one life role and one life environment.

Use of ICT

Today the mobile phone has become a social object and is present in every aspect of a user's life. The mobile phone provides a medium through which young people can mediate their social network (Taylor and Harper, 2003). Young people use mobile phones as gifts, and they have special significance in their daily lives. By analyzing various ways in which young people use their mobile phones, we can understand youth's relation to ICT and their way of living (Licoppe and Heurtin, 2001). Young people do not regard the mobile as being a work tool; they think of it as an accessory to show off to friends and to achieve a feeling of status (Dahlbom, 2003). The mobile phone is what the young person wants it to be; it becomes an individual's own personal symbol of identity.

Balance between work and leisure

Studies have confirmed that there exists a positive relationship between work and leisure that is essential for well-being (Bryce & Haworth, 2002, 2003; Haworth, 1997; Warr 1987). Additionally, previous studies have indicated that for IT-professionals conducting work from home, the boundaries between private and working life could diminish (Ahrentzen, 1990; Zijlstra & Sonnentag, 2006; Danielsson 2002). Zijlstra & Sonnentag (2006) argue that this could even affect

the ability to recover from work-related stress. They state that “*boundaries between work and home have an important psychological function: They help people to create a psychological distance between work and themselves, which is necessary to unwind*” (p. 132). According to Söderström et al., (2003), we need balance to be healthy in our lives; either it is balance between being awake or sleeping and being active or passive. If there is an imbalance in these circumstances, stress could be a result.

Earlier studies

It is worth noting that during the years 1996 to 1998 three studies were performed to analyze the introduction of *ICT in schools* (compulsory grade school and high school) in the county of Jämtland, Sweden. Results from these studies showed that majority of the schools had no written plans and strategies for buying or introducing the computer in education, and they also had no plans and policy for how to further educate the teachers. The school administrators didn't know what they should do first, educate the teachers or buy computers for use in the classrooms (Angland and Danielsson, 1996, 1997, Danielsson, 1998, Danielsson, 1999).

The aim of my first case study concerning *IT-professionals* was to describe their psychosocial life environment with focus on their private and professional roles (Danielsson, 2002). Below are some key characteristics of “young IT-people in the IT- business” and their different roles. For an extended version of the results see Danielsson (2002, 2003).

Italics show overlaps between “the Private role” and “the Professional role”.

Private role

- Don't have children and live in a central location in a big city (according to definition of the studied group);
- Goal of life is to “feel good” (both physical and psychological);
- Have *strong social networks*;
- Are *flexible* and social;
- Consider that all individuals are responsible for planning their own time.

Professional role

- Work at companies around Stureplan, a central location in Stockholm;
- Believe in their own responsibility;
- Are *flexible*;
- Experience both positive and negative stress;
- Experience anxiety;
- Consider their professional role to give meaning to their lives;
- Cannot plan holidays;

- Are experts in their area;
- Have *strong social networks*.

The Citizen role

- Have been engaged in societal issues, e.g., politics, but this engagement has ended.

Based on these results and from earlier studies, I found it necessary to perform a follow-up study that would focus on high school students, the young people who are about to enter their role as IT-professionals. I named this case study group "IT- high school students." This paper presents the results of that study.

Results

The results section is divided in topics that are selected from earlier studies preformed by the author to provide a clear comparison between the groups.

Life role

The student role (professional role)

Every school day started at 8 am and was finished at 3 pm. During the middle of the day was a lunch break between 11.25 and 12.15. During the day they spent most of the time in one class-room and didn't have to move between different classrooms even if the subjects were changing. All of the students were positive toward the scheduling for a school day, mainly because of two reasons: 1) they felt it took about 40 minutes every morning to get going with the schoolwork and, therefore, it was good to stay in the same classroom for hours so the structure of the work be stable; and 2) they felt they had time to finish their school work during the day when the teachers, supervisors and fellow classmates were there to supervise and support them in their daily school work. They could see no reason to leave the school building during the day to do the schoolwork at home or at another place. This was primarily because during the day they got the support they needed to do their work and if they were leaving the building they had to ask for permission, afterwards having to report what they had done concerning their schoolwork.

The task they were assigned during a school day or week could be finished at school, something all of the students wanted to do. By finishing the tasks during time at school they avoided having any homework. If they stayed home sick, most of them wanted to have the tasks sent home so they could keep the same pace as their schoolmates and avoid homework.

The most common way to work was in groups. The students felt accustomed to working in groups and sharing tasks. One problem was that when they gathered into groups by themselves, they preferred to work with their closest friends; the result was that the work became more unstructured and unfocused largely because the friends in the group wanted to socialise during work. The students saw another problem with the “friends” groups: the “top of the class” (students with the good grades) preferred working together while the rest (the students with lower grades) were forced to arrange their own presumably less successful work groups. The problem was that the students always worked together with friends and felt they really couldn’t develop as they would have if grouped with students other than those sharing their own particular point-of-view.

The students thought that working so often in groups was essential because they were preparing for work-life where they would probably be working together with a number of different people. Other skills required to adapt to their future professional roles would be to mix on-the-job experience and academic degrees, but to get a job, it was felt that one must have contacts with someone already in the business area.

Psychosocial effects that the students could relate to their school work were, back pain, experience both positive and negative stress and tiredness (but with no sleeping problems) and their work was in relation to their identity. The students felt a lack of being outside, during the breaks at school they just “hang around” in the building and the only ones that went outside were the smokers.

Private role

The students wanted their leisure time to be filled with activities that *they* had chosen and that *they* liked to perform. The most common activity was to “hang out” with friends, that type of activity was mainly including playing computer games or doing school-related work together “ just for the interest and fun of it”. Some of the students also said they sometimes liked to be alone, reading a book or doing handicrafts. Only the women included housework in their definitions of the home and the leisure.

” I don’t do that much, watch TV, make some food, do some shopping and wash my clothes.”

” Leisure is the time when one stays at home, rests or sleeps.”

Citizen role

None of the students saw themselves as being political active or debating in different forums, although they all continuously read the news on the Web and enjoyed discussing different subjects with friends and family. Debate in different forums on the Web was more common when they were younger, e.g., Lunarstorm (www.lunarstorm.se). Nowadays the student didn’t have the time or sufficient interest to debate in those forums; they were more eager to get their “voices

heard” in face-to-face discussions instead of virtual reality. One student was active in the community helping develop a better environment for the youth in order to lower the crime rate among young people, but he wasn’t sure that this was a regular citizen’s task.

Life environment: Home and school

The students said they only did their schoolwork during the time in school, but during the interviews they also described that they had chosen their major subjects because of an interest in the area and the fact that they really liked to do school-related work after school time that could be used/judged as school assignments.

The work place

The workplace can’t just be defined by a physical place because, with a computer, the work can be done at any place. Most of the students defined their workplace as the school building, but also their own room at home (sitting in front of the computer at the desk or in the bed). The students were negative about the ergonomically work environment at school, hard chairs and nonadjustable desks. Even if they defined a workplace to be a social environment, they also indicated that it must be a quiet place. They found it difficult to concentrate when people were talking loudly, especially on their mobile phones.

“A work place is a small area, maybe a desk and a chair. It all depends what kind of work you are doing, but in my work I need a computer, a desk and a chair.”

“A work place is a place where you work. Some people work so much so their work becomes their second home. Some people even think that their work is more important then their leisure time.”

Their home

Both men and women defined “home” as a social and emotional warm place, where one could socialize with friends and family. The private place at home represented a feeling of freedom. Most of the students lived with the parents all week but some of the students lived in their own apartments during the week and went home to the parents’ house/apartment during the weekends. The ones who lived alone during the week define “home” as the place where they would meet the rest of the family, so they went *home* during the weekends.

“Home is like a small society. When I think about home I’m thinking of my family and close friends. “

“A home is where one can take it easy, just be, and enjoy.”

If a boundary between work place and home was defined it was described as a feeling based at responsibility- work or freedom-home.

” I can’t really define a boundary between these places; they both are related to the use of the computer.”

” The boundary is that at *home* it is more relaxed but at *work* it is more serious”

Social relations

Social relations, as with friends and family, were defined as the most important relationships for the students. Because of that importance, their mobile phone was turned on 24 hours a day, seven days a week, so they would never miss an important telephone call from friends and family.

Some of the men had together with friends (only men) started their own company that they worked to develop during leisure-time. They could use some of their school work in their companies and vice versa.

Use of ICT and own responsibility

All of the students had a portable computer (borrowed by the school) and 6 out of ten used broadband at home. All of them had a mobile phone and half of them had personalized their mobile phone to make it more fun and unique (changed the shell, private or download pictures and ring signals). Those students that hadn’t personalized their mobile phones said that was not something they wanted to spend their money at.

All the students used e-mail for both private and professional use. Most of the teachers allowed the students to read their private e-mail for a few minutes before the beginning of the lecture. During the rest of the lecture time, the students were only permitted to send e-mail that in some way were related to the schoolwork. The types of e-mail that were sent during school time could not really be controlled; it was all based on some kind of agreement between the students and the teachers. However, most of the students felt that they were still able to concentrate on their schoolwork during the lesson.

During the obligatory time in school, the students use their mobile phones mostly to keep in contact with family member and friends (friends at the school, at other schools or out of school). They maintain their private relationships with friends and family in order to organize the time after school time and to be up to date about changing plans. This means that they are always alert to plan their leisure time during school time so they will know what to do after school time.

The students used their mobile phones more often to send SMS (Short Message Service) rather than calling each other. The major reason was that it was less expensive to SMS than to call. Some of the students mentioned that SMS was perfect to use when they wanted to flirt with someone because it was less

embarrassing to send a flirty SMS than to meet and flirt with a person “face to face”. For example, it felt less depressing to get “no” as an answer in a SMS than getting a “no” face-to-face. The students really preferred to have the mobile phone turned on all the time unless it was impossible (low battery level) because they worried about what phone calls and SMS they were missing.

Almost all of the students used the Internet for playing and down-loading games and music, to read the latest news and to buy things, mainly books and clothes. The most common service they used was the browser. Most of the students didn't lack any services on the Internet, a few wanted more movies and e-books and lower price to buy music and more.

The mobile phone was considered a must and a personal item. It is required that the mobile phone be turned off, but none of the students did so; they turned off only the sound. The students wanted to be able to see who was calling them; if it was their parents, they would be allowed to answer and leave the classroom. In other words, the mobile was on constantly, and in case it would run out of battery, it would be turned off against the user's wish leaving the person worried that he/she would miss some *important* call or SMS. They students were stressed when the Internet was “troubling” and they had to wait for it to function.

They all have experience about changed behavioral caused of increasing use of ICT. Positive effects were mainly the fun with computer games (and be able to earn money by plying) and the possibility to flirt with the mobile phone. Negative effects were friends that spent all their time awake by plying computer games and friends that prefer using (communication through) instant messaging because they have too low self-confidence to communicate with persons in real life.

Expert in the area

To get status in the school, one should become expert in an area, especially in a major subject. The students did much of their work in groups, and it was important to be in a group where the “top of the class” wanted to work. One student described it as an A-team and a B-team, the top of the class students wanted to work together, and the rest, the B-team, “had to” work together. A person gained status when class friends asked for help with schoolwork and when one was asked to be a member of their work-group. There was no indication that a student receiving good grades was treated as a “nerd;” instead, a person's lack of knowledge in major subjects could result in a loss of status. The high school that was used in this study had its major courses in IT and the students that choose this school also had a pre-existing specific interest in this subject, which could be a reason why the competition in a specific knowledge area was so obvious.

Overall, the students didn't think that status was something they took particular notice of and that it weren't expanded so much at their school. They were, however, worried that the local media had written negative comments about

the school and that this might lower the status of the school. If the concept of status could be seen, it was defined as superior knowledge.

Meaning of career and success

The students' views about career and promotion were focused to first get a job that one enjoys and have a salary that one could live on. After getting that job they would start thinking about a career (something fun).

Plan for the future

Concerning their future plans, the women answered that they first wanted to graduate; then they weren't sure about what would happen, probably get a job. The men answered that the future will provide them lots of fun, make them rich and successful, allow them to be self-employed, and offer more freedom and possibilities than they have today. It was noticeable that the men and women answered differently about "their future": the men saw the future as many years ahead in life while the women thought of the future in terms of the next coming month. The men had plans and dreams for the future while the women were more reserved in their speculations about the future.

Woman: "That I will finish high school"

Man: "Get some friends together and open a Web-company, become a business man"

Half of the students thought that they would spend more time at home in the future and be able to work and socialize from home with help of modern technology. By spending more time at home they thought that we would become more conformable and more social on the Net than in the real world. The other half had problem answer the question or thought that there would not be a change of living.

Advice for the future

The students were asked to give themselves advice for the future related to their professional role and private role. Half of them answered in terms of "be active, become smarter, not give up, work hard; the other half were more focused on concepts such as "not stress, take it easy, be patient, stay focused on what is important in life, do not become egotistic.

The interviews end with questions concerning what is a good life? All of them answered that the most important goal in life is to "feel good" (both physical and psychological) and to socialize with family and friends. Friends and family (love ones) gave joy to life.

Characteristics among IT-high school students

Italics show overlaps between “the Private role” and “the Professional role”.

The private role

- Don't have children
- Live at home (with parents) or alone during the weeks and with the parents during the weekends (cause of the distance to school).
- Goal in life is to “feel good” (both physical and psychological).
- Have strong social networks (*friends and family are very important*)
- Are *flexible*

The professional role

- Attending their senior year at the one IT-high school in Sweden.
- Are used/forced to work in groups (*friends are very important*)
- Experience both positive and negative stress
- Experience tiredness but no sleeping problems
- Are *flexible*

The citizen role

- Have been engaged in societal issues, e.g., politics, debate in different forums, but this engagement has ended.

Discussion and Conclusion

In this paper results have been presented from the case study “IT-high school students.” The aim of the case study is to find the relationship between ICT and the life roles and the life environment of students in the occupational group “high school students” at an IT-high school in Sweden. In this section the results are discussed to bring a deeper understanding of young people’s relationship to ICT and their way of living.

Through the results of the case study, I have found that already during high school the IT-students (future IT-professionals) had no problem working any place at any time; the ICT made it possible. The students defined their work as fun and interesting, and the use of ICT made it more fun to learn. In other words, their work environment and the home environment were converging to become a life environment in accord with Bradleys model (see fig 2).

The convergence of the different life roles (Bradley, 2001) could be discerned through the students’ daily use of ICT as, for example, their use of the mobile phone. On addition to this the students used the Internet (for example chatt, blogg, work, games), however, the type of ICT they used 24/7 was the mobile phone. The mobile phone was always turned on because the students wanted to be

easily reached by friends and family, and the mobile phone was also seen as a very important personal item. Therefore, according to Dahlbom (2003), these results also indicate that the students use the mobile phone more as an accessory and as a social tool than as a work tool. It is revealing that the students felt very uncomfortable and insecure if their mobile phones should be turned off; they were afraid to miss some important phone call or, in other words, they felt they needed to be reachable all the time.

By analysing the results concerning the young peoples use of ICT and relate them to Bradleys model (see fig 1) it is important to discuss that young people of today actually appear to be overstimulated and their reaction is stress and the fear of not “feel needed” by friends and family (always a need to be reachable). The students felt tiredness and the young urban knowledge workers both felt tiredness and had problems sleeping.

Hence, these case studies provides results that are in line with Ahrentzen (1990), Zijlstra & Sonnentag (2006) and Danielsson (2002). It indicates that even the students similar to the IT- professionals were working during leisure time such that there was a blurring or even the elimination of the boundaries between private and working life. It is important to recall that according to Söderstöm et al. (2003), we need balance in our lives to be healthy. Earlier in this paper, it is pointed out the lack of studies in this area concerning young people’s life roles and life environment. The studies I have found have mainly focused on home use or school use of ICT, but not many of the studies make detailed comparisons between the two environments. Few studies have sought children’s own views about their experiences and need of boundaries between (school) work and leisure; between the private role and the professional role, and how these boundaries could be defined when needed. Therefore, I believe that this case study provides a deeper understanding concerning work life among students that we already have seen in the regular business world (Danielsson, 2003).

To briefly summarize my conclusions in this paper, I am calling attention to the similarities between “young urban knowledge workers,” that is, professionals, and “IT-High school students” (Danielsson, 2002). The notable similarities are:

- The blurring of the boundary between school time and free time;
- The enjoyment of school work/work through “ICT”;
- Reachability independent of time and location through ICT;
- Goal in life is to “feel good” (both physical and psychological);
- Have strong social networks (friends/colleagues are very important);
- None of the them saw themselves engaged in social issues (e.g. politics);
- Experience both positive and negative stress.

I strongly emphasize the need for further research within this field. Specifically:

First, research regarding the blurring of the line between schoolwork and leisure time. Recall that the students generally agreed that they did their school-related work during their time at school. However, because of their pre-existing interest in their major subjects, they enjoyed doing school-related work after school. In short, they failed to notice that their schoolwork and leisure interests were virtually one and the same.

Second, examine the fact that there were some students who had already entered the IT-business field and were combining school, work and leisure time. Worth noting, for this purpose is that there were only men who had started to combine time for school and time for work, e.g. starting their own IT-business; the women, by contrast, were more focused on finishing their degree before seeing what might happen next.

I would also suggest a further analysis of these results in two separate papers, one paper to be focused on the life role and the other focused on the life environment. Further, I believe it would also be revealing to conduct a larger study for the purpose of providing greater knowledge about the needs of youth in setting clearer boundaries between work and leisure in order to help them reach their goal in life: to “feel good,” both physically and psychologically.

Acknowledgments

I would like to thank all the students that gave of their time to be a part of this study. I would also like to thank the teachers who cooperated by allowing me to conduct the study at their workplace.

References

- Ahrentzen, S. (1990), "Managing conflict by managing boundaries: how professional home workers cope with multiple roles at home", *Environment and Behaviour*, Vol. 22 No.6, pp.723-52.
- Allvin, M., Wiklund, P., Härenstam, A., Aronsson, G. (1999). *Frikopplad eller fränkopplad, Om innebörder och konsekvenser av gränslöst arbete*. Stockholm: National Institute for Working Life
- Allwood, C M. (1991). *Människa datorinteraktion*. Lund: Studentlitteratur
- Angland, Å. and Danielsson, U (1996). *Datorn i undervisningen*. Mid Sweden University: Department of Human Resource Development.
- Angland, Å. and Danielsson, U (1997). *Datorn – En del av vår föränderliga omvärld*. Mid Sweden University: Department of Human Resource Development.
- Aronsson, G., & Dallner, M. (1994). Winners and losers from computerization: A Study of the Psychosocial Work Conditions and Health of Swedish State Employees. *International Journal of Human-Computer Interaction*, 6, 17-35.

- Bergman, M.(1999). *På jakt efter högstadielävers Internetanvändning*. Licentiate of Philosophy. Uppsala: Uppsala Universitet Licentiatavhandling i pedagogik.
- Bradley, G. (1986). *Psykosocial arbetsmiljö och datorer*. Stockholm: Akademilitteratur 1986, first edition, Natur & Kultur 1988, 2: nd edition.
- Bradley, G. (2001). *Humans on the Net. Information and Communication Technology (ICT) Work Organization and Human Beings*. Stockholm: Prevent.
- Bryce, J. & Haworth, J.T. (2002). Well-being and flow in a sample of male and female office workers. *Leisure Studies*, 21, 249-263.
- Bryce, J. & Haworth, J.T. (2003). Psychological well-being in a sample of male and female office workers. *Journal of Applied Social Psychology*, 33(3), 565-585.
- Carlsson, I., Collberg, D., Månsson, E., Greiff, M., Starverski, H., Wigerfelt, B., Melander, F., Viggosson, H., Klapp Lekholm, A., Persson, A. (2004). *Nära gränsen? Perspektiv på skolans arbetsliv*. Stockholm: National Institute for Working Life
- Castells M. (1998). *The rise of the Network Society*. Volume 1. Malden, Mass: Blackwell Publishers Ltd.
- Dahlbom, B. (2003). *Makten över framtiden*. Malmö: Liber ekonomi.
- Danielsson, U (1998). *En utvärdering av Östersunds kommuns IT-utbildning*. Mid Sweden University: Department of Human Resource Development.
- Danielsson, U. (1999). Learning in Networks. Proceedings of *HCI International*. Munich, Germany. pp. 407-411.
- Danielsson, U. (2000). Youth in Cyberspace. Proceedings of *IRIS 23 Nordic Conference in Informatics*, Trollhättan, Information's system Research seminar In Scandinavia, pp. 1057-1064.
- Danielsson, U. (2002). *Unga Människor i storstad*. Rapportserie FSCN R-02-34.
- Danielsson, U. (2003). Young urban knowledge workers – Relationship between ICT and psychosocial life environment. Proceeding of *HCI International 2003* July. Crete, Greece.pp.941-945
- Danielsson, U. & Danielsson K. (2005). The relationship between ICT and psychosocial life environment. Short paper. *HCI International 2005*, Las Vegas, USA.
- Edström R & Riis, U med flera. (1997). *Informationsteknik i skolan*. Uppsala: Uppsala Universitet. Reprocentralen HSC
- Frankenhauser, M. & Ödman, M. (1983). *Stress: en del av livet*. Stockholm: Brombergs Bokförlag.
- Haaworth, J.T. (1997). *Work, Leisure and Well-being*. London. Roudledge.
- Hanson, M. (2004). *Det flexibla arbetets villkor – om självförvaltandets kompetens*. Doctoral Thesis. Stockholm: Stockholms university. National Institute for Working Life.
- Holme, I & Solvang, B. (1991). *Forskningsmetodik: om kvalitativa och kvantitativa metoder*. Lund: Studentlitteratur
- Isaksson, A., Hansson RIsber, E.,Toomingas, A., Hagman, M., Hansson, M., Hagberg, M., and Wigaeus Tornqvist , E. (2003) *Arbetsförhållanden och hälsa bland elever på ett IT-gymnasium med intensiv användning av bärbar dator*. Nr 2003:14 . Stockholm: National Institute for Working Life.
- Jeddeskog, G. (1994). *Datorn i undervisningen*. Stockholm: Liber Distribution. Skolverket rapport nr 94:84
- Kvale, S (1997), *Den kvalitativa forskningsintervjun*. Studentlitteratur: Lund.
- Lennerlöf, L. et al. (1991). *Människan i arbetslivet*. Stockholm: Nordstedts Juridik AB

- Lewis, S. (2003). The integration of paid work and the rest of life. Is post industrial work the new leisure? *Leisure Studies*, 22, 343-355.
- Licoppe, C. and Heurtin, JP. "Managing One's Availability to Telephone communication through Mobile Phones". *Personal and Ubiquitous Computing*, (5:2), 2001, pp. 98-108.
- Pedersen, J. (1998). *Informationstekniken i skolan, en forskningsöversikt*. Stockholm: Skolverket.
- Repstad, P. (1988). *Närhet och distans: Kvalitativa metoder i samhällsvetenskap*. Lund: Studentlitteratur.
- Riis, U med flera. (1997). *Pedagogik, teknik eller ekonomi?* Uppsala: Uppsala Universitet. Reprocentralen HSC.
- Sandberg, Å., Augustsson, F. (2002). *Interactive Media in Sweden – The Second Interactive Media, Internet and Multimedia Industry Survey*. Stockholm: National Institute for Working Life.
- Söderström, M., Jeding, K., Ekstedt, M., Kecklund, G., Åkerstedt, T. *Arbetsmiljö, stress och utbrändhet inom ett företag i IT-branschen*. Stressforskningsrapporter Nr 312, 2003, p.1-54.
- Taylor, A and Harper, R. (2003) "The Gift of the Gab? A Design oriented Sociology of young people's use of mobiles". Netherlands, *Computer Supported Cooperative work*, pp. 267-296.
- Taylor, R. (2002), "The future of work-life balance", ESRC Future of Work Programme Seminar Series, ESRC, Swindon.
- Warr, P. (1987). *Work, Unemployment and Mental Health*. Oxford: Clarendon Press.
- Wiberg, M. (2005). *The interaction society: Practice, Theories and Supportive Technologies*. Hershey, PA : Information Science Publishing
- Zijlstra, F. R. H. & Sonnentag, S. (2006). "Job characteristics and off-job time activities as predictors of need for recovery, well-being, and fatigue". *Journal of Applied Psychology*, 91, 330-350.
- Åborg, C. (2002). *How does IT feel @ work? And how to make IT better: Computer use, stress and health in office work*. Comprehensive summaries of Uppsala dissertations from the Faculty of Science and Technology 768, 3. Uppsala : Acta Universitatis Upsaliensis

Do I Have Enough Time to Visit Library before My Bus Arrives? – Exploring Compatibility And Spatial Interaction in Technology Acceptance

Teija Vainio

Tampere University of Technology, Finland
teija.vainio@tut.fi

Ilari Karppi

University of Tampere, Finland
ilari.karppi@uta.fi

Pauliina Lehtonen

University of Tampere, Finland
pauliina.lehtonen@uta.fi

Abstract Research in information system design and particularly research in technology acceptance has produced several extensions of technology acceptance model TAM. However, we argue that the earlier developed factors of technology acceptance do not emphasise the context of usage strongly enough. This study focuses on further development of technology acceptance, especially development of practical acceptability and compatibility defined earlier by Nielsen. Thus, we provide a new extension of contextual specificity, i.e. a spatial interaction, under discussion in relation to design of traveller information systems. In this paper we describe a study on the real-time traveller information system and an evaluation of user acceptance of such a system. The evaluation of the traveller system was conducted in three phases to examine the development of practical acceptability in context of usage. In addition, we explored compatibility of traveller information system and users' travelling routines. As a conclusion, we argue that contextual specificity should be taken strongly into account when designing traveller information systems for users. By doing so we can ensure that users of the traveller information systems feel that the system is developed for them and not for somebody else.

Keywords. Information technology and systems, technology acceptance, context, compatibility, human-centered computing

Introduction

In the research field of human computer interaction, usability and utility are essential elements when information systems are designed. A vital part of usability is acceptability (see Nielsen 1993). A system's acceptability can be classified into social acceptability and practical acceptability. Furthermore, practical acceptability consists of usefulness, cost, compatibility and reliability. In this study, concept of usefulness is one of the key issues. According to Nielsen (1993) usefulness is divided to concepts of utility and usability, which includes easiness to learn and remember the system, as well as being efficient to use, pleasing to use and minimisation of errors while using the system (Norman 1993).

In general in information systems research, technology acceptance and usage are key issues to focus on (Venkatesh et al, 2003). Thus, Davis (1989) presented the Technology Acceptance Model (TAM), which explains the determinants of user acceptance in information technology applications; the perceived ease of use and perceived usefulness affect intention to use an application and furthermore, intention to use affects usage behaviour. In recent studies, there have been developed several extensions to TAM model, e.g., enhanced TAM2 model (Venkatesh and Davis 2000), the simplified technology acceptance model can be also described as external variables, which affect perceived ease of use and perceived usefulness (MacFarland and Hamilton 2006, 429).

The influences of contextual specificity are emphasized in recent studies of the TAM model. Task structure, prior experience, other's use, organizational support, anxiety and system quality directly affect the acceptance of information technology (McFarland and Hamilton 2006, 441). One of the key issues in contextual specificity is computer-efficacy, which affects the user's affective state, user anxiety, and system usage and outcome expectations (Compeau and Higgins 1995).

In the research of technology acceptance, compatibility and beliefs of compatibility have been in the center of recent studies of TAM extension (see e.g. Karahanna et al., 1999, Taylor and Todd, 1995). When studying technology acceptance with a bank customer relation management system, Karahanna et. al (2006) argued that compatibility could be classified into compatibility with existing practises, compatibility with prior experinece and compatibility with values.

In this paper, contextual specificity is examined in terms of spatial interaction. By examining spatial interaction, we could emphasise the physical space where the user actually use the system in more detail. By doing so we seek to demonstrate how the introduction of new public travel information interfaces is here in fact related to the more general chage in urban morphology. We describe the implementation of a real-time traveller information system for public transportation in the city of Tampere in Finland and present some of the system's

effects on public transport users. In this paper, we first discuss the social context of the information and then concentrate on practical context of the information system. Furthermore, we describe and analyse how local users have accepted the public transport information system and what kind of changes or effects the system might have created considering the users' travel behaviour. In our study we concentrate on exploring user acceptance, compatibility and outcome expectations in the real-time traveller information system used at the bus stops and inside the buses.

Contextual specificity of the System

Tampere, located in southern Finland, is the urban core of the Tampere Metropolitan Area (TMA, pop. ca. 315 000) and a larger economic Tampere Region (pop. ca. 450 000). The city of Tampere's central business district (CBD) is located on a kilometre-wide part of an isthmus between two large lakes. Its particular physical features comprise rapids that originally formed the eastern boundary of the city, and the world's highest gravel ridge (postglacial shoreline, ca. 6000 BC, of what became the Baltic Sea) signifying the narrowest part of the isthmus, west of the contemporary city centre. Despite the challenging physical conditions the isthmus has been a natural location for a major east-west land route dating back at least to the late Middle Ages.

Modern Finnish traffic and transport geography has its roots in the TMA. Reino Ajo (1944) studied the formation of the Tampere traffic area in the 1930s, applying the then up-to-date American and German approaches to the analysis of spatial interaction over physical space. His accurate survey of the functional structuring of the Tampere CBD, published right at the aftermath of the WWII, paved the way for a series of subsequent analyses on the growth and restructuring of the downtown. Its essential feature is the dominance of a one kilometre-long east-west main street, the Hämeenkatu. It starts from the railway station, crosses the rapids, runs through the most important shopping, administrative and entertainment district, as well as the most important node and crossover point for local and metropolitan bus transport.

The CBD's distinctive east-west design is both geographically and socio-economically embedded. The industrial energy provided by the rapids was among the key factors of Tampere being founded, in the late 18th century, with a royal decree as an industrial town. Thus, a particular industrial logic emerged as a cultural backbone to mark major streaks of the city's future development. Banks of the north-south rapids were the location of industrial premises, and the rest of the town was structured relative to this resource. The east-west continuum also constituted the most significant basis for the city's social structuring. Locations in

leafy grounds closest to the factories were taken over by the factory-owners; the zone right beyond their premises was allotted to the managerial staff, and the zone still further away to the ordinary workers.

In time Tampere grew as Finland's most important regional centre, second only to the Helsinki Metropolitan Area. Regular bus traffic in the TMA started in 1920, and the Tampere City Transport was created in 1948. However, there is still a great variety of private operators linking particularly the Tampere CBD and the surrounding municipalities of the TMA. Due to the spatial attributes derived from physical geography and historical developments the Hämeenkatu main street has become the main traffic corridor for both Tampere City Transport and operators of TMA regional bus traffic.

Public transport in a contested space

Congestion is a global rush-hour phenomenon. In the case of Tampere CBD it is made particularly severe by geography that limits the east-west thoroughfares. It is alleviated worldwide with traffic limitations and rush hour fees levied on private automobiles, such as the 2006 Stockholm congestion charge trial (Stockholm trial 2006). An alternative paradigm obviously more acceptable to the citizens seeks to make public transportation more smoothly-rolling and thus appealing to the service users, enhancing thus its competitiveness. Traditional solutions to do this include part of the traffic lanes reserved solely to public transport, traffic light priorities given to approaching buses, or enhanced accuracy through route planning. A more modern solution, particularly while operating in physically contested space, is to bring individual bus stops to the information age. Real-time information on buses arriving to a given bus stop enables the individual service users to make more rational personalized time-use plans (cf. Hägerstrand 1978, 214-215). This would reduce the slack time caused by one's need to adjust his or her individual timetables to the buses' success in making their ways to pick the passengers from bus stops. In the case of Tampere it is important to note that the first monitors for real-time bus information were planted in bus stops along Hämeenkatu main street. Thus the service users were required to adopt the new information system in the city's most congested traffic channel, surrounded by greatest possible amount of traffic-related information, but also with the greatest choice of alternatives to invest their newly "generated" time resource.

More accurate traffic information makes the time reserves hidden by the rigidity of traditional insensitive printed timetables more tangible. Thus, new time reserves are made available to the individual service users. From the concentration of economic and administrative activities along the CBD central axis follows one key assumption. The newly liberated time reserves will be used in a movement that flows along the core stream of the main street's traffic, eastward or westward. The underlying motivation for liberating time to be invested in high street consumerism can be criticised as an imprint of urban pro-

growth regimes (cf. Newman & Thornley 1996, 81-84) that *per se* conflict with the ideology that seeks to promote the use of public transport. However, the process's later stages have revealed signs of a public-private endeavor to keep the inner city as a viable and well-functioning part of the citizen's daily environment.

Market-related use of public space is an intrinsic feature of Tampere main. Its attractiveness to various businesses due to a superior local and regional attainability is also visible in Ajo's (1944) data from the 1930s. Changes to the pattern that it reveals speak for even more explicit concentration. This concentration, in turn, helps in keeping the service users within the reach of a more continuous flow of traffic-related information. The bus stop information monitors provide them with information on the relative time locations of buses that might best match with their transportation needs. Such a constant flow of information would be harder to provide in a functional downtown structure with the demand for CBD activities directed more centrifugally away from the main traffic artery.

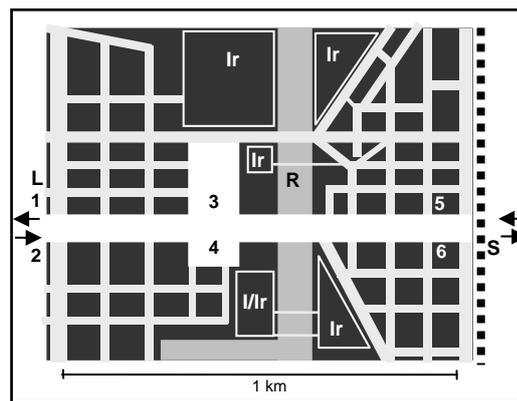


Figure 1. A schematic map of downtown showing the relative locations of bus stops. L= central library, C=central square, R=the Tammerkoski Rapids, S=railway station. Ir=old industrial sites restructured into business, residential or cultural use, I=old industrial site still used by industries.

Related work

Information systems for travellers have been the focus of recent studies, particularly in the area of developing information systems for individual car drivers or in the area of developing information systems for passengers of buses. Studies and implementations have concentrated on providing either multimodal information or real-time information for passengers. Real-time at-stop information seems to meet user expectations well, for example, displays provide information about waiting times and the location of the arriving vehicle, aiming to remove uncertainty and minimise the waiting time of passengers.

In previous studies in HELMI and the ELMI projects in Finland, passenger surveys were conducted before and just after installations of surveys, the at-stop displays are already being used more often than paper schedules. In terms of the usability of the system, the symbol was understood well, but the square symbol indicator was more difficult to understand; less than 40 % of the interviewed passengers understood the symbol. In Sweden, in the Malmo Smile project, displays are designed to use at bus stops, as well as near some shopping centres and the attention has turned to multimodal information representation (Civitas Initiative 2005). In addition, the research focus has been on mobile applications (Transport for London) and Advanced Traveller Information Systems (ATIS) (see Ran 2000). In our study, we focus on practical and social acceptability issues in the design of the public traveller information systems.

Horn (2004) has studied journey-planning procedures designed for use in a traveller information system covering fixed-schedule and demand-responsive public transport modes. He concludes that

“...the main planning procedures are a high-level request-broker and a branch and bound procedure to handle multi-legged journeys; the request-broker also invokes a fleet-scheduling module to obtain bookings on demand-responsive services” (Horn 2004).

Moreover, in studies on the Advanced Traveller Information System (ATIS), information provision is becoming more pervasive; for example, prediction models and their functional requirements and capabilities are at the centre of attention in recent studies (Ran 2000).

Recent studies about traveller information systems have stated passengers' attitudes towards systems, that waiting itself at the bus stop is felt to be more acceptable, as time seemed to pass more quickly when they knew how long their wait would be; passengers perceive a shorter waiting time, the service is perceived as more reliable, and for those passengers travelling or waiting at night, it is perceived as safer. In terms of ergonomic aspects, many of the bus stop displays are situated in the direction of the arriving vehicle (Infopolis, 1999). In London, there are information systems under development in which a user could have real time bus service information by receiving a SMS text message on a mobile device before entering the bus stop, and at the bus stop a user is able to confirm on a display that a bus will arrive at a predicted time. Moreover, after boarding the bus, a user can see an on-board sign and voice announcement about the next stop (Transport for London 2005).

As McFarland and Hamilton (2006, 441) have stated, the influence of contextual specificity should be emphasised in studying systems with the TAM model because task structure, prior experience, others' use, organisational support, anxiety and system quality directly affect the acceptance of information technology. Contextual specificity has been noted in the studies of traveller information systems as well:

“First of all, the user prepares his future travel, the planning step defines the way in which the tasks must be performed to attain the goals of the travel, and each user has different task criteria concerning his personal context and reasons for travelling. During the trip, the results highlight that the main task carried out by the traveller is the 'tracking', which includes two sub-topics: orientation and decision making. The last results show that the user acquires experiences from his travels and applies the new knowledge to future trips. Thus, through a feed-back loop, the assessment task serves to influence the planning and the tracking tasks. The defined travel process sequence consists of three time-based contexts” (Infopolis, 1999).

In the Infopolis project, the adaptation of information in three different contexts was studied. In the pre-trip context a user needs information, for example, about the trip, ordering/reservation and payment, and real-time pre-checking information. Recommended functions are planning, checking, warning and customising. The system could be terminals used at home. In an on-trip context the user needs information about localisation and orientation, checking and anticipation. Furthermore, recommended functions (see table 1) are trip re-conception, signing and overlapping. Systems could be on-board collective/individual terminals, portables, public Interactive Terminals and bus stop displays. In addition, in the end-trip context the information needed is related to localisation and orientation. Moreover, the functions can be orienting and signing. Systems could be interactive maps. (Infopolis, 1999)

Table 1. Time based context (Infopolis, 1999)

Context	Main task	Needs
Pre-trip	Planning	Adapted information systems
On-trip	Tracking	
End-trip	Assessment	

In our study, we were interested in evaluating the traveller information system both in the context of the pre-trip and the on-trip.

Evaluation

The objective of this study is to examine the usability of and usefulness of the information systems focusing on usefulness (according the TAM model) and particularly the focus was on context issues related to user acceptance.

The evaluation of the traveller information system was conducted in the streets of city during the summer 2004.

System description

The traveller information system development was started in 2003 and it serves the public transport users by offering real time information about local bus transportation and bus schedules. Moreover, it provides bus drivers with information of current timetables and information if the bus is driving on schedule.

The system is based on satellite-based location (DGPS). The system includes at-stop displays (see figure 2) and displays inside busses. The displays at bus stops present information of timetables and waiting times and the displays inside busses show names of bus stops.



Figure 2 Electronic bus stop display at the street

Hypotheses

We consider following hypotheses in evaluating the system, as stated below.

- H1 The familiarity with the routes and schedules will have a negative direct relationship with the system usage
- H2 The frequency will have a positive direct relationship with system usage
- H3 Perceived ease of use will have a positive direct relationship with system usage
- H4 Assessments of perceived usefulness will have a positive direct relationship with system usage

Subjects

There were altogether 1142 subjects (see table 2) in this study. The study included three phases. First, the user interviews at bus stops conducted during summer 2004 and second, the user interviews at bus stops carried out during winter 2004. In addition, a user query was conducted in 2004.

The first phase of user interviews was conducted at bus stops in June 2004. The volunteer 198 subjects were recruited from six different bus stops in which the information system was implemented by screens displaying the bus schedules. 74 % of these subjects were female and 26 % were male. The 64 % of the subjects were aged between 10 and 40 and the rest 36 % were between 41 and 83 years. The subjects had a mean age of 37, 6 years. Of the subjects 56 % were using bus almost daily, 23 % a couple of times during one week and the rest were using bus less than once a week.

The second phase of user interviews was conducted at bus stops in December 2004. In this phase there were 445 subjects, 66 % were female and 34 % were male. The 61 % of the subjects were aged between 11 and 40 and the rest 49% were between 41 and 88 years. A mean age was 37, 6 years. Of the subjects 70 % use bus almost daily, 22 % of them a couple of times during one week and the rest were using bus less than once a week.

In the third phase, a query was conducted concentrating particularly adaptation of the travel information system inside the buses during journey. There were 499 subjects, 79 % were female and 21% were male. The 54% of the subjects were aged between 12 and 40 and the rest 46% were between 41 and 82 years. Of the subjects 62% were using bus almost daily, 28% of them a couple of times during one week and the rest were using bus less than once a week.

Table 2 Background information of the subjects

	The first phase	The second phase	The third phase
Subjects (n)	198	445	499
Female	74 %	66 %	79 %
Male	26 %	34 %	21%
Aged between 10-40 years	64 %	61 %	54%
Aged between 40-88 years	36 %	49%	46%
Using bus daily	56 %	70 %	62%
Using bus couple times per week	23 %	22 %	28%
Using bus less than once a week	21 %	8%	10%

Method

The research material was collected by interviewing the users of the local transport and sending them a query. Each subject was interviewed while they were waiting a bus in a bus stop. These interviews comprised of 15 questions in total and breaks down as:

- Questions 1-4, 7 and 15 background information (when, who, where)
- Questions 5 (assessments of usefulness)
- Questions 6, 8, (usage and usability of the system before the bus comes to a bus stop)
- Questions 9-11 (usefulness and problems)
- Questions 12-14 (effects to plan the journey)

The interview form had questions considering the background information (when, who, where). It also had questions about the usage and usability of the display screen showing times of arrival and questions of the usefulness and problems of the system and the screens. It also included questions concerning the system's possible effects to plan the journey.

In the survey conducted in December 2004, there were questions of background information, usability and usefulness of the displays inside the buses. This survey comprised of 16 questions in total and breaks down as:

- Questions 1-2 (usage and usability of the system inside the buses)
- Questions 3-5 and 16 (assessments of usefulness)
- Questions 6- 8, (usage and usability of the system at the bus stop)
- Questions 9-11 (transportation, usefulness and problems)
- Questions 12-15 background information

Procedure

In the interviews, in addition to background information, the subjects were asked at the bus stops if they have noticed the at –stop displays, and if they had noticed them, then they were given a task to seek information about the next arriving bus and asked to explain the information presented on the display. Furthermore, the subjects were asked if they found the system were useful or not and what kinds of problems they had while they were using the traveller information system at the bus stop. The usefulness of the system at the bus stops were studied more detailed by asking if the subjects would see that

- The information presented on the displays is trustworthy
- Waiting time seem to be shorter
- It is important to know that the bus is not passed the bus stop yet
- It is easier to choose between the buses when seeing those schedules on the displays
- Waiting time could be spent by doing something else, e. g. by going indoors or shopping
- There are some problems with using the system, e.g. the information is not experience as trustworthy, the display and the information on the display are difficult to see, the display is not functioning or the information is presented unclear

During December 2004, a third survey was conducted focusing on issues related to usage of the traveller information system inside the buses. The survey included questions about

- Have the passengers noticed the displays?
- Are they using the system?
- In what way the information system could be useful to them?
- Are there any problems in using the system?
- To whom is the system designed for?



Figure 3. At-stop displays

Overall, current existing at-stop displays provide real-time information on the arrival of the next vehicles. The content of the given information is usually the same: route number, destination of the arriving vehicle and waiting time. Some displays show the location of the arriving vehicle on a linear map and about half the systems give information on service disruptions. The Metro platform displays in Helsinki give information about the vehicle: they use a symbol to display the length of the train. The most common additional information is current time; some displays can provide free text messages (Civitas initiative, 2005).

In our study, the at-stop displays provide information on the arrival of the next vehicle presenting route number and waiting time (see figure 3).

Results

In this study, a one-way ANOVA (ANalysis Of VAriance between groups) was performed to analyse the gender and age issues. The ANOVAs included gender and usage as the between-participants variables, and usefulness as the within-participants variable. There seems to be no significant differences with the system usage between females and males or between different ages. Moreover, there are no statistically significant differences between females and males regarding their opinions of the system's usefulness.

In relation to the usability of the system, the most important usability issue seems to be the bad visibility of the display on the bus. At the bus stop, (see figure 3) the subjects were asked when a certain bus was arriving and 85 % of the subjects answered correctly. When the subjects were asked about the other symbols on the display, 75% of the subjects knew the right answers. In conclusion, there seem to be no major usability problems with the user interfaces.

Considering the usefulness of the system, we found that in summer 2004, 76% of the interviewed users considered the information system to be useful or very useful. In winter 2004, this amount was increased to 80 %. According to the query, 88% of the respondents regarded the system as useful or very useful. In addition, the use of the system increased. When 31 % of the users in the summer of 2004 utilised the system regularly, in the winter of 2004 regular use had grown over 50%.

Moreover, the more familiar the subjects seemed to be with their bus route and their own bus stop previously, the less they used the system. The result correlated statistically significantly ($p < 0.01$). There was no correlation between how often a passenger travelled by bus and used the system inside the buses, but there was a correlation between how often a passenger travelled by bus and used the system at the bus stops. This correlated statistically significantly ($p < 0.01$). In conclusion, the usefulness of the system is assumed to be designed for those who do not know the bus routes or neighbourhood. Moreover, those subjects who knew their bus's time of arrival did not use the system at the bus stops.

Table 3. Usefulness of at-stop displays

Benefits	Passengers (%) of total
No need for paper schedules	37
One is able to see what time it is	12
Know that they missed the bus	11
Easy to choose a suitable bus	6
Other	10
No opinion	21
Nothing useful	3

Considering perceived usefulness at-the bus stops, the most useful aspect for the passengers seemed to be to that, they did not need the schedules printed on paper anymore (see table 3). As a conclusion of the perceived usefulness of the system inside the buses, 88.5% thought that the displays inside the buses were

very useful or useful. In table 4 more detailed descriptions of the benefits are presented. Moreover, the study indicates that passengers think that the system is useful for those who do not know the neighbourhood.

Table 4. Usefulness of displays inside the buses

Benefits	Passengers (%) of total
Know what bus stop to get off at	30
Know the location	39
Useful for visitors	46
Not useful	7

In our study, we were interested in possible problems that the system may include (see table 5). Inside the buses, for passengers difficulty in seeing the displays and information presented on these displays on the bus correlate with not using the system. The result is statistically significant ($p < 0.05$).

Table 5. Problems with the at stop displays

Problem	June 2004 (%)	December 2004 (%)
Waiting times are not trustworthy	11,6	22,8
Difficulty in seeing the displays	2,5	1,6
The system is not functioning	1,0	8,5
The information is represented in an unclear way	0,5	2,5
Other	1,5	3,8
No problems	41,4	35,8

Problems with using the system are vital to user acceptance. According to our study, trust is the key issue here. This may be related partially to the fact that we had quite a long testing period (one year) in our study. In addition, during the evaluation, at-stop displays were only partially functional. Some passengers, who used the same bus stop daily, may have thought that the system was still not fully functional and therefore not always trustworthy. On the bus, our study indicates

that there were no major or statistically significant problems with using the displays.

Discussion of results

We explored the traveller information system with the technology acceptance over six months in the city of Tampere, emphasising usefulness issues and particularly studying the explanations of the determinant of user acceptance, compatibility and contextual specificity. Therefore, we have proposed that when information systems for travellers are designed, attention should focus on the following issues:

If users are familiar with their travelling routes and bus stops, they consider that new information systems are not designed for them.

In public places, such as at bus stops, problems during the testing period may affect users' involvement with the final system, e.g. by feeling the system is still trustworthy.

Users should be guided to use the publicly available systems before and during the actual final implementation.

Furthermore, we argue that the contextual specificity understood as task structure, prior experience, other's use, organizational support, anxiety and system quality (McFarland and Hamilton, 2006) should be taken into account when travelling information systems are designed. Our results indicate that the prior experience on travelling particular route on a bus affect on perceived usefulness of the information system. Also the system quality, and in our case user's notion of system quality already during the testing period have effect on acceptance later on. In addition, we argued that usage of the information system might vary in different locations of the city. User's goals and benefits to use the travelling information system could differ depending if she/he is standing at a bus stop in front of the library in a peaceful suburban area or at the bus stop in the city centre along a main street during a rush hour. Therefore existing spatial interaction are essential to consider when the contexts of technology acceptance of travelling information systems are explored.

REFERENCES

- Ajo, R. 1944. Tampereen liikennealue. Kansantaloudellinen yhdistys. Helsinki.
- CIVITAS Initiative 2005, Available at <http://www.civitas-initiative.org/main.phtml?lan=en>
- Compeau and Higgins.1995. Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly* 19, 2, pp. 189-211
- Davis, F., D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13/1989, pp. 319-339.
- Horn, M., E., T., 2004. Procedures for planning multi-leg journeys with fixed-route and demand-responsive passenger transport services. *Transportation Research: Part C*, Feb2004, Vol. 12 Issue 1, pp. 33
- Hägerstrand, T. 1978. A note on the quality of life-times. In T. Carlstein, D. Parkes & N. Thrift (eds) *Human activity and time geography*. London: Edward Arnold. pp. 214-224.
- McFarland, D., J., Hamilton, D., 2006. Adding contextual specificity to the technology acceptance model. *Computers in Human Behaviour*. Vol. 22, pp. 427-447
- Nielsen, J., 1993. *Usability Engineering*. Academic Press. Inc.
- Newman, P. & A. Thornley. 1996. *Urban planning in Europe. International competition, national systems and planning projects*. London: Routledge.
- Infopolis, 1999. Traveller Needs in the Field of Multimodal Information - Analysis of the travellers needs in real situations. Results. Available at <http://www.ul.ie/~infopolis/travelle/index.html>
- Karahanna, E., Straub, D., W., and Chervany, N., L., 1999, Information Technology Adoption Across Time: A cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs . *MIS Quarterly* , Vol. 23, No 2, pp. 183-213
- Karahanna, E., Agarwald, R., Angst, C., M., 2006. Reconceptualizing Compatability Beliefs in Technology Acceptance Research. *MIS Quarterly*, Vol 30, No 4, pp 781-804
- Ran, B., 2000. Using traffic prediction models for providing predictive traveller information. *International Journal of Technology Management* 2000, Vol. 20 Issue 3/4, p. 326
- Taylor, S., Todd, P., 1995, Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research*, Vol 6, No 2, pp. 144-176
- Transport for London. 2006 iBus - Try the new bus travelling experience. Available at <http://www.tfl.gov.uk/buses/ini-ibus.asp#bustrial>
- Venkatesh, V., and Davis,, F., D., 2000. Theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*: 46, No 2, pp. 186-204
- Venkatesh, V., Morris, M.; G., Davis, G., B., and Davis, F., D., 2003, User acceptance of Information Technology: Toward a Unified View. *MIS Quaterly*, Vol. 27, No, 3, pp. 425-478

The Question of Responsibility for Long-term Digital Preservation

Mari Runardotter

Social Informatics, Luleå University of Technology, Sweden

Mari.Runardotter at ltu.se

Anita Mirijamdotter

Social Informatics, Luleå University of Technology, Sweden

Anita.Mirijamdotter at ltu.se

Christina Mörtberg

Department of Informatics, University of Oslo/University of Umeå,

Norway/Sweden

chrismmo at ifi.uio.no

Abstract. This paper intends to analyze and discuss the matter of responsibility for long-term digital preservation. The reason for this is that previous research has shown that for the moment the responsibility many times rests solely with archivists (Runardotter, 2007). This is a rather problematic scenario, considering that their professional background builds on archival theory, and that archivists are recognized as being connected with paper, or analogue, media. We thus concentrate on archivists' current situation and the impact of information technology and long-term digital preservation on the same. We start with analyzing archivists' current situation from three arenas – the local, the managerial and the national. Based on this we discuss constructions of archivists in relation to information technology, whether archivists are regarded as keepers or facilitators, and what kind of actor role archivists are assigned. Finally we discuss what the constructions imply concerning the responsibility for long-term digital preservation. We have found that archivists and national policies have a rather coherent view. The responsibility for long-term digital preservation should rest with management, and archival matters should be approached in a pro-active manner. Archival matters are a concern for the organization per se, and cooperation and coordination of responsibility issues is necessary. Finally, archivists should be participating actors in IT and long-term digital preservation matters, and focus on facilitating access to archival material.

Keywords. Long-term digital preservation, Digital archives, Actors, Agendas.

Introduction

Information technology (IT) has made it possible to produce more recorded information than humans have ever done – and people do. But today much of this information is less accessible than ever before, or even lost, and it is easy to agree with Duranti (2000) that this is one of the ironies of the information age.

Archivists have traditionally been regarded as keepers of the societal memory (Cook, 1997). They were supposed to keep archival material intact and care for it. Therefore it might not be surprising that this view still exists, and that archivists nowadays are expected, both by themselves as well as others, to take on the challenge to keep digital records for long-term. A plausible consequence of this expectation would be to involve archivists in issues concerning IT and information systems (IS) in organizations, since this is the technology through which digital records are produced. Many archival theorists claim that archivists must have a pro-active role and be involved when IT-systems are to be bought, or (re)designed and implemented (see e.g. Bearman, 1994; Cook, 1997; Dollar, 1992; Duranti, 2001; ICA, 2005). In addition, this is in line with the underlying ideas in participatory design, that focus on use or work practices increase both mutual learning between designers and users, and the advantage of motivated users of the systems (see e.g. Bratteteig, 2004; Bødker, Kensing & Simonsen, 2004, Gärtner & Wagner, 1996; Runardotter, 2007).

This is however not what it looks like in many Swedish organizations when it comes to digital archival matters. On the contrary, many archivists are not invited or asked for opinions when organizations' computer-based information systems are on the agenda (Runardotter, 2007). If archivists had a more pro-active role and were involved in organizational systems design, archivists could more easily move towards a role as facilitator, as suggested by Cook (1997). This means that archivists should focus on access, not mere preservation (Menne-Haritz, 2001). However, preservation is a prerequisite for access, therefore the intention should be to preserve, or keep, the digital records for viable futures, not just keeping the records intact.

Although not involved in IT issues, many archivists act as if long-term digital preservation is their responsibility, insofar that they are the ones who are attentive to and raise the issue. According to the Swedish Archives Act (SFS 1990:782, 4§) every authority is responsible for the care of its archives, unless an archival authority has taken over the responsibility. Hence, it is the authority that is responsible. But the question remains – whom at the authority should be responsible for digital archives and long-term digital preservation? In practice the responsibility issue is muddy, one archivist that took part in one of our studies

stated that "... in my county council the responsibility for IT issues and long-term digital preservation is very unclear. Who owns the question?" (Runardotter, 2007). Moreover, many organizations seem to have placed the responsibility for long-term digital preservation with the archivists. This can of course be regarded as natural since the preservation of information is the fundamental reason for the archival profession. But we wonder whether it is adequate to place the entire responsibility for long-term digital preservation on one professional group, that is archivists, considering that digital material is kept within a technology that is unfamiliar to many archivists but also that this is an issue for connecting present events with the future. The archivists we have interviewed were certainly seeking support and cooperation, and meant that IT-personnel and management also must acknowledge the matter (Runardotter, 2007).

Hence, for the purpose of this paper our focus is on the responsibility for long-term digital preservation. Our aim is to analyze where the responsibility for long-term digital preservation is found and expected to be found, according to archivists and national policy documents respectively. We intend to identify what similarities and differences can be found between the archivists' views and national policies, and what consequences does this bring along.

The reasons for our interest in these matters stem from our concern that if archivists in different organizations are the only ones expected to secure the preservation of digital records, long-term digital preservation is jeopardized. Instead we argue that cooperation among different professional groups is fundamental, if information about our contemporary society will be accessible in the future.

The analysis in this paper is based on four different studies. The first is participatory observations and involved following an authority archivist in her daily work. This took place from April 2005 until June 2006. The second study consists of a brainstorming conducted by 34 participants at a conference for county council archivists in December 2005. Thirdly, a future workshop with 6 archivists and one registrar was carried through in March 2006, and finally, in April 2006 a focus group interview was done, with 3 persons that work at an existing e-archive¹. Hence, our analysis and discussion is based on the stories these archivists have told us.

The outline of the paper looks as follows: first we describe our analysis method. Thereafter we provide the current situation as described by the interviewed archivists and in theories. We then describe and analyze archivists' view of the local and managerial arenas, followed by an analysis of national policies. Then we discuss our findings – that is how archivists are constructed and the responsibility for long-term digital preservation. Finally we draw our conclusions and provide some suggestions for further research.

¹ For a more detailed description of the different studies, see Runardotter (2007).

Methods for Analysis

We intend to analyze where the responsibility for long-term digital preservation *is found* today, and where it *should be found*, according to the interviewed archivists and national policy documents. Hence, the analysis is based on archivists own stories and analysis of the Government bill *Arkivfrågor* (Archival Issues, Prop. 2004/05:124), and the Swedish Government Official Reports *Arkiv för alla – nu och i framtiden* (Archives for everyone – now and in the future, SOU 2002:78), and *Ordning och reda bland offentliga handlingar* (Orderliness among official records, SOU 2002:97). Our analysis will examine how archivists themselves and national policy documents talk/write, or not talk/write of archivists and the responsibility for long-term digital preservation.

For the analysis of responsibility we will use a framework by Gärtner & Wagner (1996), which is developed in order to make it possible to discuss the political and organizational context of design and participation. The reason for using it is that it provides us a framework that covers three arenas in which national policies are interpreted and translated. The framework is described below.

Using Arenas for Mapping Actors and Agendas

Gärtner & Wagner (1996) observes that the Scandinavian approach of participatory design is supported by a strong tradition of workplace democracy. However, they argue that political issues seem to have vanished in favor of the partnership between designers and future systems users. Therefore they provide a framework that enables discussion of the political and organizational context of design and participation. The framework involves actor networks, where asymmetrical power relations are a concern.

According to Gärtner & Wagner (1996) the arenas for participation and space for action are Arena A – where the design of work and systems takes place, Arena B – where organizational frameworks for action are designed, and Arena C – the political arena. Important to remember is that the arenas exist in parallel and influence each other, and not necessarily forms a top down hierarchy (Elovaara, 2004). Hence, control, steering, etc. might come from any one of the arenas. For example, changes in legislation (the political arena) will affect the local level, but the latter might interpret and implement an adjusted or adapted version. Following this, "... perhaps Arena A is also a space for resistance or re-negotiation of the ideas developed and worked out in arenas B and C" (Elovaara, 2004, p. 133).

Arena A is where specific systems are designed, and the concrete work with enhancing things such as workplace skills and working conditions takes place. The agenda of (re)designing work and technical systems involve issues such as skills, procedures, communication and cooperation, but also dependency and

automation. Negotiations concerning productivity and social agreements happen in Arena B, and are conducted by actors that represent groups both from within and outside the organization. Participation is indirect and eventual conflicts are regulated in a more institutionalized way. Moreover, Arena B constitutes the location where conflicts are diagnosed, questioned and redesigned. Finally, at Arena C negotiations of the general legal and political framework takes place. This involves the establishment of norms for work-related issues, norms that often are culturally specific. However, this arena increasingly involves global spaces, since we live in a world where the flow of people, money, goods, information and technical systems is becoming more and more common. Actors are not necessarily spatially and culturally close to one another and transnational regulations address domains of human practice (Gärtner & Wagner, 1996).

Archivists Current Situation

In Sweden the principle of free access to public records as stated in the Freedom of the Press Act (SFS 1949:105) together with archival activities provides the foundation for archives. To have freedom of the press is regarded important to research and culture, but also to an open, democratic society in general (Gränström, 2005). This means that archives have become an important source of scientific and technical knowledge, roots and memory, and the identity of people, families, social groups, enterprises, and public and private communities (Delmas, 2001). The archival idea is thus to provide a societal memory, which means that archives are more than information (Cook, 1997). In archives we find both evidence of the organizations' transactions and the cultural heritage (Bearman, 1994; Dollar, 1992).

To arrange and describe archives, build structures and processes around archival matters, plan and control records management, and inform, support, and educate are activities that are involved in archivists' work practices. The practice also includes providing records and other requested documents to citizens who ask for them. As long as this happened in a solely paper-based environment it all went on smoothly. But today archivists have to navigate between old and new technologies, with a mix of paper-based and digital records, which make their work situation rather chaotic (Barata & Cain, 2001).

Archivists work is to a large extent regulated by the principle of provenance, which states that archives must be kept carefully separated and are neither to be mixed with other archives nor placed in artificial arrangements based on chronology, geography or subject. The arrangement of archives must be based on the original order or organisation of the archival collection (Cook, 1997). Dollar (1992) states that the provenance principle means to know where a document was created, in what process, to what end, for whom, when and how it was received by the addressee and how it came into our hands.

Appraisal is another important concept for archivists, and it can be regarded as systematic methodologies for the selection of records of archival value (Dollar, 1992). Today, when people produce born-digital records and handle multimedia systems, geographic information systems, integrated relational databases and complex databases that cross organisational boundaries, it is not possible to focus on master files or historical files as was possible when it came to machine-readable records. The integrated nature of databases and complex systems undermines the notion of the uniqueness of a computer's ability to process and link. Dollar (1992) claims that there is need to formulate other appraisal criteria and introduce them into the design of computer systems.

According to the in total 45 persons² that have taken part in the research underlying this paper, their current situation, which embraces long-term digital preservation, is distinguished by several difficulties. The areas where the difficulties are found are: work activities – cooperation and communication – organisation – professional roles and competences – resources – attitudes – IT – laws and regulations³. In short, regarding *work activities* the greatest difficulty is how to work with digital archives, archivists simply do not know how to carry on this task. In order to safeguard records, many print paper copies, to ascertain that it will remain for the long-term. *Cooperation and communication* between different professional groups, around long-term digital preservation is non-existing in many organizations. Especially this concerns archivists and IT-personnel, but also management. For example, the archivists meant that archivists and IT-personnel cannot talk with each other, and even when they use the same words they mean different things.

Organization has, according to archivists, to do with that their organizations are neither adapted nor prepared for long-term digital preservation. The issue is not on the agenda yet. Many archivists express insecurity regarding their *professional role and competence*. They are not clear over what they need to know of systems development and/or systems design themselves, and mean that different professional groups in the organization needs more knowledge in archival theory, laws and regulations. That archives lack of *resources* is also expressed by archivists. Time, money and personnel would help. The *attitudes* towards archivists, archives and archiving are negative, argue archivists. They are regarded out-dated and old-fashioned, low prioritized and neglected, and archivists are mainly associated with paper. When it comes to *IT* several difficulties arise, such as digital records are not regarded as official records, how and when should e.g. websites be preserved, the computer based systems should be able to “do more”, systems are not integrated or coordinated etc. Finally, IT has

² These 45 persons are mainly archivists; all 45 are involved in long-term digital preservation at their organizations. The organizations, in turn, covers authorities, municipalities and the 21 Swedish county councils (<http://www.kgab.se/mpn/landstng.htm> [2007-05-21])

³ For a more detailed description of the different areas, see Runardotter (2007).

got another consequence – the respect for *laws and regulations* is declining. Legislation is by archivists regarded as inconsequential and ambiguous.

Archivists' View of the Local Arena

Archivists work is to a high degree regulated by traditional archival concepts such as provenance, appraisal and original. Thus, they have knowledge of archival theory, but also of relevant archival laws and regulations (Runardotter, 2007). We argue that inherent in archival concepts is a view of the paper-based archive, since the concepts are developed when the paper-based archive was the only type of archive. Also, laws and regulations lag behind and are not fully adapted for the digital era, even if this work is ongoing. This means that archivists in many cases follows and accomplishes their work practice based on slightly old-fashioned theories, laws and regulations. Few of the interviewed archivists questioned the relevance of the concepts or whether e.g. appraisal needs to be revised, adapted or treated differently when it comes to digital objects. However, one archivist noted that there are “Problems with appraisal in older systems”.

Original is somehow different though, because they are aware of the possibilities that IT brings along, such as faster and easier access and availability to digital objects. The problematic around what constitutes the original is therefore more or less accepted. However, archivists own knowledge in laws and regulations is not the problem, but as two archivists expressed it, “to get the legal to function at work”, and “to get the organization to work in accordance with the guidelines that actually exists” is harder.

What differs between archivists and other professionals is that besides using IT, they are supposed to take care of the information held within the same technology. The information to be cared for and preserved exists in a technology with which archivists feel unfamiliar. Hence, they can no longer feel content that the digital information in the organizational systems is trustworthy, authentic, reliable or accessible in the future. As an example, one county council archivist at the archival conference stated “561 IT-systems and databases. No appraisal plans, no documentation and no plan of how to treat personal information”. Today these archivists know that official records such as web pages are lost, since they do not have a clue of how to preserve them. As a consequence of this many of the archivists think that they need more knowledge in systems development and technical issues in general.

Archivists are expected to preserve (and use) organizational IT-systems, but many times archivists have neither taken part in the purchase process, nor been asked for what needs to be considered from archival perspective regarding IT-systems. Reasons for this could be their unclear role, and low status in the organization and the fact that archivists are regarded to deal with paper, as they themselves express it. Another reason is that archiving is low prioritized in the

organizations. Moreover, many organizations face lack of integration and coordination of their many systems. One archivist stated “Purchase of IT-systems has been strongly decentralized, which has resulted in an amount of systems that cannot communicate”. In addition, the interviewed archivists claim that many systems would be able to do more, which shows the lack of archival concerns when systems are bought or (re)designed. Almost every interviewed archivist is certain of the need for cooperation and communication, and they convey the overall impression that if this was to be established, the situation would change profoundly. But a lot of archivists express similar concerns as the archivists that said that “IT-personnel run their own race without concern for archiving, preservation and appraisal” and that it is, as another archivist argued, “Difficult with impact and attention for archivists’ knowledge and competence”. Hence, one problem is “System developers. I do not want to run after them all the time”.

To sum up this section – what thoughts do archivists express concerning long-term digital preservation and responsibility? We argue that the archivists we have met look to the future with confidence, but they are convinced that it demands cooperation to accomplish and secure long-term digital preservation. They lack competence and knowledge, and one archivist asked “What competence in IT and long-term digital preservation archivists should have?” At the same time archivists claim that other involved professionals do not realize or pay attention to long-term digital preservation – one of the interviewed explained that “systems are sometimes implemented without consideration of archival and preservation aspects”. Another issues archivists has pointed at is that soon as information becomes digital, the responsibility is taken over by other professionals. “Archivists should only care for paper, is a common attitude” as one archivist expressed it, and therefore archivists are shut out when IT and digital records are on the agenda. Hence, the current situation worries archivists since they claim that other professionals neglect archival as well as long-term digital preservation issues.

Archivists’ View of the Management Arena

Some archivists meant that archivists have to market themselves in order to counteract that they are neglected. Archives are regarded as a service function, since others expect immediate help when wanted, i.e. archivists are expected to leave whatever they are doing and answer any requests immediately. To regard archives as a service function is of course not wrong – they are. But archives are more than that – organizational archives can fill the role of evidence of transactions, and organizational memory. As such they also have a wider importance than merely service.

The archivists argue that most other professionals in the organizations involved in records management neither have insight in archival matters nor do they see

archives as carriers of memory. It is hard to secure that the records management process runs smoothly, i.e. that those administrators or other personnel expected to conduct certain archiving tasks know exactly what to do. According to one archivist there is no “coordinated or overall view, regarding technology and activities” and another said that there is “No organization or technology (or competence) for how to receive digital archives”. To be the only archivist in an organization with almost 1500 employees, as is the situation for the authority archivist we have followed, implies that engagement and interest as well as support from management are essential, she stated. But this is something she experience that she does not get.

Archival routines and methods are not well known, archiving is not an ongoing activity and even if templates exist they are not obvious for people who do not know archiving. Moreover, “the respect for laws and regulations is declining”, according to one archivist, and not found among others in their organizations, e.g. digital documents are not regarded as official documents, said the authority archivist. Hence, the need of at least some knowledge in archival theory concerns all in the organization.

Moreover, cooperation, communication, long-term strategies and a common and coherent view on the matter is missing in many organizations today. Most digital archiving is conducted ad hoc, and in order to secure the mission of preservation, many archivists declared that they print out on paper to be sure that official documents will prevail.

To end the analysis of Arena B – most of the organizations in our studies do not have a genuine and thorough strategy for long-term preservation, they have not succeeded to establish cooperation in their organization around the matter and it is not clear who should be responsible for this. Instead the archivists in our studies gave expression that it is them that, rather alone, struggle for the preservation of digital material for long-term.

National policies

In the Swedish Government Official Report SOU 2002:78 is stated that long-term digital preservation and digital material puts greater demands on authority archivists. Therefore, further education for archivists is a precondition if digital archival material is to be managed and preserved in a purposeful and safe way. Hence, archivists are regarded to need competence in systems development, process analysis and modeling. The responsibility for further education should rest with archival authorities. It is also argued that archivists’ professional role is not homogenous, and specialization is an option.

Technological development has changed the conditions for archival authorities, e.g. do digital archives facilitate access for citizens (SOU 2002:78; Prop. 2004/05:124). Despite this, IT can never replace an engaged and knowledgeable

person – hence positions as archival pedagogues are suggested. They should be a resource for the entire archival sector and cooperate with libraries, museums and different organizations (SOU 2002:78).

IT raises the importance of taking measures in an earlier stage than paper, since it is not possible to organize digital material afterwards (SOU 2002:97). At national level IT is regarded as a means that facilitates and makes archival activities more efficient, it expand the overview of, as well as the accessibility to, archival material, according to the Government Bill (Prop. 2004/05:124).

In SOU 2002:97 it is argued that increased knowledge of regulations concerning the right to access to official documents is needed among both administrations and the public. The report clearly states that all personnel must have knowledge of archival regulations, and be able to apply them in their ordinary activities. Moreover, it is obvious that it is authorities' management that are responsible for securing that the principle of free access to official documents has impact in their ordinary activities, and that their personnel has adequate knowledge – and use it. Finally, management holds the responsibility to make sure that accessibility and insight into the authorities' affairs are not negatively affected by organizational changes or new technical solutions (SOU 2002:97). Hence, accessibility is regarded as a direct result of IT and an issue in all three documents analyzed. The work for accessibility of archival material must be strengthened (Prop. 2004/05:124).

Digital archival material and the public sectors effort for a coherent e-government, with its service oriented approach towards citizens, place new demands of every authority's archival activities and functions. Common standards and norms for archives are regarded to secure the coherent e-government. To bring forth these standards and norms should be the responsibility of a supervisory authority. Moreover, archives are regarded as fundamental, if Sweden will live up to its intention of e-government (SOU 2002:78). Connected to this we find the suggestion of a technically neutral regulation that provides a good structure among official documents in order to provide for the principal of free access to official documents. This regulation would state that authorities should organize official documents so that a clear separation of official documents from other can be done. Official documents should be presented as when they arrived at the authority, and be presented in such a way that the process of which they were part is reproduced (SOU 2002:97).

The investigators draw the conclusion that municipalities and county councils have not had the same resources, especially within the digital area (SOU 2002:72), as the Swedish National Archives and the Regional Archives. This indicates that at national level there is awareness of the lack of resources among archival creators identified in our studies. In SOU 2002:78 is argued that contemporary financial and personal resources are not satisfying among archival authorities, which cannot manage and safeguard digital information produced

within official administration today. In a prolonged perspective there will arise new principles for how archives come up, administers and are made accessible in the public sector (SOU 2002:78).

Concerning digital archiving cooperation is mentioned. Archival authorities must take part in development work, and cooperate with other archives and archive creating authorities (Prop. 2004/05:124). The cooperation needs to revolve around development of methods and routines for digital archives, and how digital material can be prepared for transfer to the archival authority (SOU 2002:78). Archives, libraries and museums and other authorities and organizations, both public and private, should be part of the cooperation (Prop. 2004/05:124). The methods needed are for information- and system analyses, and metadata connected to authenticity and appraisal. At national level a common infrastructure for the entire official administration is wanted, e.g. databases should function together in a safe and rational way. Pro-activity is necessary – the possibilities to preserve digital information is settled early in the information life cycle, states SOU 2002:78. In addition, electronic documents must be organized so they are searchable and easy to find (SOU 2002:97). In SOU 2002:97 is also added a new regulation concerning appraisal needs, since contemporary law does not take into account digital objects. In Prop. 2004/05:124 is also argued that IT should be developed in international cooperation.

Finally, at national level long-term digital preservation is an issue for everybody, i.e. the Swedish National Archives and the Ministry of Education, Research and Culture cannot alone handle the matter. Instead SOU 2002:78 argues that the question must embrace all ministries, and be defined as a concern for the entire official administration. Long-term planning and preservation strategies are needed, that are synchronized with the e-government as well as library and museum efforts for long-term digital preservation. Overall, IT is regarded a tool for making archival activities easier and more efficient, and it provides an increased overview over archival material (Prop. 2004/05:124).

Discussion

In this section we will discuss where the responsibility for long-term digital preservation is found and expected to be found according the interviewed archivists, and national policy documents. What similarities and differences can be found between the archivists' views and national policies? What consequences does this bring along? We also discuss whether archivists are constructed as keepers or as facilitators, and what kind of actor role they are assigned in relation to information technology. Finally we will discuss implications of this regarding the responsibility for long-term digital preservation.

Constructions of Archivists

What is meant by preservation? In an archival context, and concerning analogue records, it could be to make sure that the material is in good shape and conserving it over time, thus keeping it. We use the term *keeper* as a definition for a view of archivists as those expected to solely retain archival material, a paper-based view that lacks the understanding of the impact of IT on archives, and possibilities that the technology brings along. By *facilitator* we refer to a view influenced by the impact of IT, and thereby a view of archivists as those holding the intellectual control over (analogue and digital) archival material, and acts as mediators, that is facilitates, access to this material (Cook, 1997). In other words, facilitator is to be interpreted as an extension of a keeper, keeper is inherent in facilitator.

In order to keep archival material there are two strategies from which to choose: care for the original and lend it to the customers, risking the status of the original, or provide users with a reproduction as a means of preserving and caring for the original. Archivists are well aware of what is expected of them, this as an example of their embodied knowledge (Haraway, 1991; Jansson, Mörtberg & Berg, 2007) – archivists know archiving, archival theory and regulations by heart. We argue that archivists construct themselves mainly as keepers, archivists still think in a paper based way. They are protecting and securing the information they are supposed to preserve, keep it intact, and cared for. This task is needed also in the future, since it could be said to constitute the archival idea, of evidence and memory (Bearman, 1994; Cook, 1997).

When it comes to digital records the question of what constitutes the original is fuzzier. Media fragility and technological obsolescence means that the term *preservation*, as applied to electronic records, no longer refers to the protection of the medium of the records but to that of their meaning and trustworthiness as records (Duranti, 2000). And the most important question is whether or not to focus on the future, that is, whether archives should be closed or opened? (Menne-Haritz, 2001). In other words, preservation strategies have to respect records potential usefulness for interpretation and reflect on how to keep them visible or re-constructable. This involves stabilizing traces that emerge from common activities and communication during the birth of the records (Menne-Haritz, 2001). Preserving traces that facilitate interpretation becomes an important task for archivists. When it comes to electronic preservation, the consequence is that records must be kept unchanged, but there is also a need to prepare for re-constructability of the original contexts (Menne-Haritz, 2001). If we are to interpret this as a work activity for facilitators, this work has only just begun. Archivists do not have the intellectual control over digital records, since a great deal of this information is lost today. But the work has started and is ongoing.

At the management arena we can state that many organizations have only begun to realize the importance of starting the (re)design of their archives. Moreover, they have not secured that different IT-systems are compatible. It

would therefore be easy to argue that among personnel at management level there is no awareness of all the implications long-term digital preservation brings along. Not involving archivists when it comes to IT issues, shows that organizations do not realize the need for a common effort in this matter, that is, they do not secure that their systems are prepared for and contain all the information needed in order to safeguard organizational evidence and societal memory. Moreover, other personnel still regard archivists to be keepers – keepers of paper-based, or analogue media.

This implies that if we are to focus on long-term digital preservation for future access, and if this is most urgent to deal with if we are to secure the societal memory and cultural heritage for future generations, then the consequences of *not* dealing with the issues of archival matters and long-term digital preservation are not fully understood among involved persons in organizations, such as management and IT personnel. Other professional groups in the organizations involved in our studies, mainly management and IT personnel, do not take on the responsibility for long-term digital preservation.

But awareness is rising. The authority is definitely starting to pay attention towards digital archives, the Archival Conference invited us from the LDP project as speakers, the Future Workshop participants attended because of consciousness of the matter, and the county council e-archive has really made an effort in order to deal with the issue. Apart from this there are other initiatives around Sweden, such as the projects REDA⁴, AGDA⁵ and SVEP⁶. From this we would say that in Sweden long-term digital preservation is in a start up phase, and much is to be expected in the future.

What does it look like at national level, then? What view of archivists can be discerned? First and foremost, in the three national policy documents access is a watchword (SOU 2002:78; SOU 2002:97; Prop, 2004/5:124). This would imply that in order to make digital records accessible, we should need facilitators, and these should be archivists – and even more specific, archival pedagogues (SOU 2002:78). In SOU 2002:78 it is clear that authority archivists need education in systems development – hence, archivists should be competent in IT. Hence, at national level the view on archivists is more blurred. Perhaps the interpretation should be that the view of archivists as keepers is still present, but the wish to change this view towards facilitators is obvious. Even if archivists become facilitators, as is the intention in the policy documents, there is awareness of the need for archival regulations among all personnel, and the public (SOU 2002:97).

-
- 4 Information about the project available at <http://dspace.slu.se:8080/dspace/bitstream/123456789/48/1/REDA+f%3Frstudierapport+slutlig.pdf>
- 5 Information about the project available at <http://dspace.slu.se:8080/dspace/bitstream/123456789/47/1/Slutrapporten+ver.3.doc>
- 6 Information about the project available at <http://www.svep-projekt.se/preservation/>.

When mentioning responsibility, SOU 2002:97 places this on management. It is management that should secure that access to official records is possible.

What are not explicitly mentioned in the national policy documents, though, are IT-departments and IT-personnel. System developers are not explicitly included, neither as a resource, nor as an asset, when it comes to long-term digital preservation. The general statement is that everybody should be included (i.e. citizens should have access to easily accessed search tools), but concerning the actual work to be carried out for long-term digital preservation in organizations, IT-personnel is not mentioned. There is need to develop methods for information analyses, as well as systems analyses by archival creating authorities and other official archival institutions (SOU 2002:78), but whether IT-personnel should be included in this work is not clearly stated.

Important to note, however, is that archival authorities with a supervisory role, such as the Swedish National Archives, has its own IT-department. The policy documents analyzed in this paper probably rests on an implicit presupposition that the Swedish National Archives covers the systems design and technology aspect. Additionally important is that the policy declared by the government must be translated and negotiated in the different practices by people who are involved in the practices (Gansmo, 2003). We claim that the one who receives information from the Swedish National Archives at local level is the archivists, not systems developers. It is probably at the local level, where there is room for renegotiation of decisions made at national level, the work to spread the responsibility for long-term digital preservation must start (Elovaara, 2004).

To make long-term digital preservation work demands coordination to make it happen – cooperation between different actor such as archivists, IT personnel and management is necessary. This can be compared with introduction of e-government, which causes changes in service provision, services and citizenship, and demands cooperation between the actors involved (Elovaara, 2004).

Finally, what actor role are archivists assigned in relation to technology? Based on the studies we would say that archivists are engaged and willing to become involved in systems design to a much higher degree than what is today. The authority study showed that the archivist was well aware of shortcomings in many systems, and meant that better systems would be able to “do more”. In other words, archivists could very well regard themselves as digital actors, but they are not really ‘let in’, by IT-personnel. Both parts express that the others “are not possible to talk with”. The difference is, according to archivists, that they are troubled over the situation, while they describe IT-personnel as more or less unaware or uninterested. Maybe IT-personnel have a stronger belief in technology, and are less worried that the problems today will not be solved? However, even if this wish to be a participating actor is discernable, the fact that archivists and archival matters are neglected provides a view where archivists are

put aside. They have to do with the systems as they are, and cannot yet actively partake in systems design in their organizations.

At national level the underlying message is that archivists should be more active in systems design. Perhaps even more since IT-personnel are absent in policy documents. Instead archivists should be educated (SOU 2002:78), in order to cope with long-term digital preservation themselves. If help is to be expected, it should come from archival authorities (where of course system developers could be a part) (Prop. 2004/5:124). To sum up, in national policy documents there is no awareness to be found, whether long-term digital preservation demand cooperation among different professional groups in an organization. The message in these documents is that archivists should deal with the issue, and management is to be held responsible for its accomplishment.

The Responsibility for Long-term Digital Preservation

Whom or what should be the carrier of the societal memory – archivists, or technology? We argue that the national discourse in many ways already has replaced archivists with the technology. Or put otherwise, IT has replaced archivists as carrier of evidence of organizational transactions and the societal memory. Hence the keeper of the archives today is technology. A role as facilitator should therefore evolve for archivists, in the sense as being the person who facilitates access to the material. But this is today prevented, since archivists are regarded as keepers – they are not able to make a difference in their organizations.

To be a keeper of something is followed by a responsibility as being the one who secures that it endure. Therefore, it is not surprising that organizations holds archivists responsible for long-term digital preservation. There is thus not awareness of the shift in roles between archivists and IT in many organizations. On the other hand, not being a participating actor provides us the opposite view. If archivists are not allowed to have their say in the organizations' systems development, where do we place the responsibility then? On archivists? Is it reasonable to place responsibility on a professional group that is shut out from anything that has to do with the technology that keeps the records they are expected to preserve?

In addition, IT replaces archives as place, but this change has not really affected that much – maybe it will be more obvious in the future when those asking for records and documents might be able to search themselves, in their homes by their own computers. But IT also replaces the archivists as keeper. If the responsibility for long-term digital preservation is spread and shared among archivists and IT personnel, what happens then? What are the implications of this? The most burning questions for archivists today are perhaps what competence and what role would they prefer in the future? It is adequate to ask whether archivists should 'give away' all their knowledges and competence to a

IT system. If they do, what is left for them (Elovaara et al, 2006)? What do they need as facilitators?

We have argued for the need of cooperation around responsibility for long-term digital preservation. Both archivists and national policies place responsibility with management. A probable scenario is that managers are aware of this, but once an archivist is employed, the responsibility is transferred and the issue is regarded as solved. One barrier for the transition of electronic records management is the “inability to express archival concerns in ways which is shared by executives, managers, auditors or information systems specialists” (Reed, 2000, p. 2). So the question maybe should be put otherwise – is it archivists responsibility to establish the cooperation around the matter of responsibility for long-term digital preservation? Not according to the Archives Act (SFS 1990:782), and we agree. This is a concern for the organizations’ management groups, it really should be their responsibility to sort out where and who should take on the responsibility for long-term digital preservation. This cannot be the archivists alone. And of course, every organization must find their appropriate solution (Reed, 2000).

Conclusions

This paper has focused on where the responsibility for long-term digital preservation is found today, according to interviewed archivists and national policy documents. The answer on this question is based on whether archivists are regarded to be keepers or facilitators, as well as what role they are assigned. We have mostly identified similarities between the archivists’ views and national policies with very few, small differences, and also discussed what consequences this brings along regarding the responsibility for long-term digital preservation. Our conclusions are as follows.

A view of archivists as keepers moving towards facilitators can be discerned, this view is conveyed both by archivists themselves, as well as in national policy documents. However, the view is not clear cut – the interviewed archivists are ready to become facilitators, and this is also the underlying intention in the national policy documents. But to become a facilitator demands that you also are a participating actor in IT issues. Today the archivists we have met are not involved in this area. That is, they have to deal with the information systems in their organizations, with little to none opportunity to influence the same. This is in contrary to both archivists own will, and also to national policies. The consequence of this scenario is that too often it is solely archivists that are held responsible for long-term digital preservation, a situation which jeopardizes the same.

We argue that the main challenges are found in the fact that when it concerns long-term digital preservation, cooperation and communication among different

professional groups in organizations does not function properly. To get this to work is essential if our society is to safeguard the societal memory, and the cultural heritage. Moreover, in line with the national policy documents as well as legislation, we claim that managers must realize their responsibility and create preconditions for the establishment of a cooperative and coordinated diffusion of the responsibility for long-term digital preservation. Involved should be, at least, archivists and IT personnel, besides managers themselves. The reasons for this are that archivists know archival matters, IT personnel know the technology, and management actually holds the ultimate responsibility because of their organizational role.

Further research

How is the archival profession to evolve? What knowledges and competences will they need as actively participating actors and facilitators of future digital archives? These are questions that would be very interesting to explore further.

Another tricky area to investigate would be how to raise awareness, interest and understanding of the long-term digital preservation challenge among management groups and IT personnel, hence design of organizational framework is important, which means that Arena B should be focused.

Acknowledgments

We want to thank the anonymous reviewers at the IRIS 30 Conference, whose comments, ideas and suggestions hopefully very much improved this paper. Others eyes on ones own work is valuable – one often takes ones own understandings as common, when writing. Reviewers are good at waking you up. Thank you all, for doing that!

References

- Barata, Kimberly & Piers Cain (2001). "Information, Not Technology, Is Essential to Accountability: Electronic Records and Public-Sector Financial Management", in *The Information Society*, Vol. 17, pp. 247-258.
- Bearman, David (1994). *Electronic Evidence. Strategies for Managing Records in Contemporary Organizations*. Archives & Museum Informatics, Pittsburgh.
- Bratteteig, Tone (2004) *Making change. Dealing with relations between design and use*. Doctoral thesis, Department of Informatics. University of Oslo.
- Bødker, Keld, Finn Kensing, & Jesper Simonsen (2004). *Participatory IT Design. Designing for Business and Workplace Realities*. The MIT Press, Massachusetts, USA.
- Cook, Terry (1997). "What is Past is Prologue: A History of Archival Ideas Since 1898, and the Future Paradigm Shift", in *Archivaria*. Vol 43, pp. 17-63.

- Delmas, Bruno (2001). "Archival science facing the information society", in *Archival Science*, Vol 1, pp. 25-37.
- Dollar, Charles M (1992). *Archival theory and information technologies. The impact of Information Technologies on Archival Principles and Methods*. University of Macerata.
- Duranti, Luciana (2000). "The InterPARES Project", in *InterPARES Symposium Proceeding, February 2000 - The complete proceedings from the February 2000, InterPARES Symposium*. Available at <http://www.interpares.org/> [2007-03-27]
- Duranti, Luciana (2001). "The impact of digital technology on archival science", in *Archival Science*. Vol 1, pp. 39-55.
- Elovaara, Pirjo (2004). *Angels in Unstable Sociomaterial Relations: Stories of Information Technology*. Dissertation Series No 2004:02, Blekinge Institute of Technology.
- Elovaara, Pirjo and Teddy Igira and Christina Mörtberg (2006). "Whose Participation? Whose Knowledge? Exploring PD in Tanzania-Zanzibar and Sweden". In *PDC 2006 – Proceedings of the ninth Participatory design Conference 2006*. Available at <http://portal.acm.org/citation.cfm?id=1147277&coll=GUIDE&dl=GUIDE&CFID=1112529&CFTOKEN=81820933> [2006- 11-13]
- Gansmo, Helen Jøsok (2003). "Limits of state feminism" in Merete Lie (ed) *He, she and IT Revisited*. Gyldendal Akademisk, Oslo, Norway.
- Gränström, Claes (2005). "Arkivteori", in Ulfsparre, Anna Christina (ed.). *Arkivvetenskap*. Studentlitteratur, Lund.
- Gärtner, Johannes and Wagner, Ina (1996). "Mapping Actors and Agendas: Political Frameworks of Systems Design and Participation", in *Human-computer Interaction*. Vol 11, no 3, pp. 187-214.
- Haraway, Donna (1991). *Simians, Cyborgs, and Women. The Reinvention of Nature*. Free Association Books, London.
- ICA (2005). *Electronic Records. A workbook for Archivists*. International Council on Archives, ICA Study 16. Available at <http://www.ica.org/biblio.php?pdoid=285> [2006-11-14]
- Jansson, Maria, Christina Mörtberg & Elisabeth Berg (2007). "Old Dreams, New Means: An exploration of visions and situated knowledge in information technologies". *Gender, Work & Organization* 14, pp. 371-387.
- Menne-Haritz, Angelika (2001). Access – the reformulation of an archival paradigm. In *Archival Science*, Vol. 1, pp. 57-82.
- Prop. 2004/05:124 *Arkivfrågor*. Available at <http://www.regeringen.se/content/1/c6/04/12/58/dd87b9c4.pdf> [2006-12-11]
- Reed, Barbara (2000). *Electronic Records Management in Transition*. Available at <http://www.sims.monash.edu.au/research/rcrg/publications/brep3ert.html> [2005-09-06]
- Runardotter, Mari (2007). *Information Technology, Archives and Archivists – An Interacting Trinity for Long-term Digital Preservation*. Licentiate Thesis 2007:8, Dept. of Business Administration and Social Sciences, Luleå University of Technology, Luleå. Available at <http://epubl.ltu.se/1402-1757/2007/08/index.html> [2007-03-27]
- SFS 1949:105 The Freedom of the Press Act. Available at <http://www.notisum.se/rnp/sls/lag/19490105.htm> [2006-11-10]
- SFS 1990:782 The Archives Act. Available at <http://www.notisum.se/rnp/sls/lag/19900782.HTM> [2007-05-24]
- SOU 2002:78 Arkiv för alla – nu och i framtiden. Available at <http://www.regeringen.se/sb/d/108/a/1493> [2006-12-11]
- SOU 2002:97 Ordning och reda bland offentliga handlingar. Available at <http://www.regeringen.se/sb/d/136/a/3809> [2006-12-11]

National Enterprise Architectures in the Scandinavian Countries

Katja Liimatainen

University of Jyväskylä

Information Technology Research Institute

katja.liimatainen@titu.jyu.fi

Governments through out the world have established numerous e-government projects. Today many countries are integrating their disjointed projects into national enterprise architecture (NEA) programs. NEA is seen as an imperative to success in the rapidly changing governmental environment, since it can provide structure and direction to the decision making process. The purpose of NEA is to ensure interoperability, avoiding duplication efforts and enable government wide reuse. We present an evaluation framework and compare the NEA programs of the Scandinavian countries. As a result, we find that Finland, Denmark and Norway have NEA programs and Sweden is considering about initiating one. There are differences and similarities in the programs.

Keywords. E-government, National Enterprise Architecture, Scandinavia, Evaluation framework

Introduction

Many governments around the world have established national enterprise architecture (NEA) programs to ensure interoperability, having help in avoiding duplication efforts and enabling government wide reuse. An enterprise architecture explains how all the elements in an organisation – systems, processes, organisations, and people – work together as a whole (Morganwalp and Sage, 2004). By identifying, structuring and categorising elements, EA can increase the potential for cross-public sector reuse and reduce duplication and hence reduce costs (Ministry of Government administration and reform, 2006). The rapidly changing environment that all organisations must operate in creates a

situation where enterprise architecture is seen as an imperative to success (Ashmore et al., 2004).

In this article we focus on the public sector reform in development of ICTs and governance by evaluating Scandinavian NEA programs. National unit has been chosen as an analysis unit since the research on EA in governmental context has been lacking. Furthermore the Scandinavian countries have been among the frontrunners for e-government by pushing ICT in intra- and intergovernmental operations and launching services for external users. We found out that this is somewhat true also in establishment of NEA programs. We believe that the Scandinavian countries are especially interesting to the IRIS audience. Motivation for this research was to gain knowledge on government's use of enterprise architecture.

This article is organised as follows. In the first chapter, we briefly describe background and previous studies by describing development in governments from e-government towards national enterprise architectures. In the second chapter, we present an evaluation framework for evaluating NEAs. In the third chapter, we evaluate e-government and NEA programs of the Scandinavian countries. Finally we present concluding remarks by summarising the results of the evaluation.

From Fragmented e-Government Projects Towards National Enterprise Architecture Programs

Today, many governments face the reality of diminishing budgets. At the same time there is a need to offer better access and better and more efficient services to citizens, companies, and other governmental agencies. The drive to accomplish more with fewer resources has led in investments in information and communication technologies (ICT) to redesign internal and external processes based on the opportunities provided by technology (Andersen, Grönlund, Moe and Sein, 2005). Public administrations all over the world promote ambitious and costly e-government programmes to provide electronic access to government services (Peristeras and Tarabanis, 2004). E-government refers to ICT enabled change in governmental institutions at all levels from national to regional to local (Kawalek, Wastell and Newman, 2003).

Key reasons for public sector reform have been increasing the efficiency of government operations, strengthening democracy, enhancing transparency, and providing better and more versatile services to citizens and businesses (Coe, Paquet and Roy 2001, Ho 2002, La Porte, Demchak and de Jong 2002, Watson and Mundy 2001, Flak, Olsen and Wolcott 2005). In many political speeches or pamphlets, the public is confronted with the notion of a close and positive correlation between information technology, public services, and democracy (Ilshammar, Bjurström and Grönlund, 2005).

According to Flak and Rose (2005) there are difficulties in the practice of e-government, with government targets reported as vague (Muir and Oppenheim, 2002) and many e-government initiatives described as chaotic and unmanageable (Layne and Lee, 2001). Recent studies have indicated that e-government initiatives have not held their promise of improving government services, since cost reduction has been the major driver behind the development (Flak, Olsen and Wolcott, 2005).

One solution towards better e-government initiatives has been benchmarking other countries' e-government solutions. OECD, for example, has published country reviews (e.g. OECD, 2003, 2005a, 2005b) and there are also studies that compare countries e-government projects (Accenture 2006, Cap Gemini Ernst & Young 2003, Dalziel 2004, Ronaghan 2002, United Nations 2003). According to Flak et al. (2005) international surveys place the Scandinavian countries among the more mature in Internet penetration, user experience with IT/IS, and sophistication of e-government services. In addition, the Scandinavian governments are among the frontrunners in showing enthusiasm for e-government by pushing ICT in intra- and intergovernmental operations and launching services for external users (Andersen et al., 2005).

E-government has not been able to solve the concern many organisations have about how to utilise ICT to its fullest strategic extent. One solution has been to initiate an enterprise architecture (EA) program. Both industry and governments all over the world have recognised the special value of enterprise architecture (Schekkerman, 2004). The rapidly changing environment that all organisations must operate in creates a situation where enterprise architecture is seen as an imperative to success, since it can provide structure and direction to the decision making process (Ashmore et al., 2004). According to Rico (2005) enterprise architecture is the premier approach for evaluating the information technology needs of local, state, federal agencies, and also large corporations. As well as e-government, the enterprise architecture promises results in better, faster, and cheaper information technology, which satisfies organisational goals and objectives. Compared to e-government initiatives EA programs are often more holistic approaches that intertwine and focus disjointed e-government projects.

EA is a hierarchical approach to aligning business and ICT (Langenberg and Wegmann, 2004). An enterprise architecture explains how all the elements in an organisation – systems, processes, organisations, and people – work together as a whole (Morganwalp and Sage, 2004). By identifying, structuring and categorising elements, EA can increase the potential for cross public sector reuse and reduce duplication and hence reduce costs (Ministry of Government administration and reform, 2006). Implementation of enterprise architecture offers a way forward in integrating independent ICT silos across inter-organisational agencies. This integration is seen important in the most governments of Western countries. As part of the public sector modernisation plan, governments seek to offer their

citizens a seamless service delivery by linking various independently developed systems and applications. (Janssen and Kuk, 2006) With EA it is possible to describe the current state of the organisation and also plan the transition from the present state to the desired state.

Interoperability and integration is becoming increasingly important when public organisations implement and manage EA programs and governing interoperability across organisational domains requires that public agencies take into consideration other parts of the public sector (Hjort-Madsen, 2006). EA can serve as an umbrella for explaining the relationships among the independent e-government projects and managing change. According to Janssen and Hjort-Madsen (2007) in governmental context EA's are often denoted as national enterprise architecture (NEA). The purpose of NEA is to ensure interoperability, avoiding duplication efforts and enable government wide reuse (Janssen and Hjort-Madsen, 2007).

Today public sectors ICT initiatives can no longer be developed in silos with no regards to other parts of the government (Hjort-Madsen, 2006). However NEA programs face integration and interoperability challenges within and between public agencies that are difficult to overcome in governments (Hjort-Madsen and Burkard, 2006). Challenge of the NEA programs is that government structures often impede the success of EA (Hjort-Madsen and Gotze, 2004). According to Christiansen and Gotze (2007) 67 percent of governments already have NEA programs and added to those the countries that are planning to have a program within one or two years the percentage is 93,3.

Research on actual EA activities has been scattered. Schekkerman has conducted research on international EA activities. He has conducted three surveys on the progress of EA usage and implementations in several organisations all over the world (Schekkerman, 2005). His surveys address governmental and nongovernmental organisations. According to Christiansen and Gotze (2007) the surveys ignore the level aspect and hence leave unclear whether the governmental respondents are answering from national, regional, municipal, departmental or agency level. NASCIO (2004) has published a report that gives an overview of the EA status in the United States. Since the year 2002, United States Government Accountability Office (GAO) has published several reports on assessment of EA maturity of agencies. In the year 2002 they gathered benchmark data about 116 departments, component agencies, and independent agencies in the United States (GAO, 2002). Reports have shown that the progress in EA is slow in the majority of the agencies (GAO, 2004, 2006). Perhaps the most comprehensive study on international EA activities is done by Christiansen and Gotze (2007, first reported in Christiansen, 2006 and Christiansen and Gotze, 2006). Objective of their survey was to obtain a comprehensive overview of the EA activities. They collected data from sixteen countries on how governments

are working with EA on a national level. Unfortunately, they do not report the results by country.

In this study we focus on Scandinavian NEAs. As mentioned before Andersen et al. (2005) state that the Scandinavian governments enthusiastically promote e-government. We wanted to see if the same enthusiasm is presented in initiating the more broader and holistic NEA programs. Before the country reviews we present the evaluation framework.

The Evaluation Framework

In the evaluation of Scandinavian NEAs we use an evaluation framework that is based on the framework of Janssen and Hjort-Madsen (2007). This framework was selected, since it is the only comprehensive for evaluating NEA's. The framework is construed from five viewpoints that are 1) Policies, actors and structures, 2) Governance, 3) Architecture frameworks and methodologies, 4) Architecture principles and standards, and 5) Implementations. We found the framework useful but not comprehensive enough. We added two viewpoints that are 1) Benefits and 2) Evaluation. These viewpoints are needed to see the bigger picture when comparing NEAs. The framework is presented in the Table 1. Next we describe the framework in more detail.

Viewpoint	Explanation
1. Policies, actors and structures	Political and environmental drivers for NEA. The strategic objectives for architecture are provided by political actors and constrained by democratic structures.
2. Governance	NEA's governance model and practices that are needed for keeping the architecture uptodate. Governance guidelines also encourage desired behavior.
3. Architecture frameworks and methodologies	Definition of the NEA, used framework and architecture process.
4. Architecture principles and standards	Used standards, principles, guidelines for implementation and change control.
5. Implementations	NEA implementations and cross public sector projects.
6. Benefits	Benefits of the NEA work, measurement, experiences from NEA work and from its usefulness.
7. Evaluation	Evaluation of the NEA work.

Table 1. The evaluation framework (adapted from Janssen and Hjort-Madsen, 2007)

Politics, actors and structures

This viewpoint encompasses the environmental and political drivers for the NEA. The strategic objectives for architecture are provided by political actors and constrained by democratic structures (Janssen and Hjort-Madsen, 2007).

Governments have different goals for their NEAs. Over 90 percent of the governments report that their motivation for NEA is improving cross governmental interoperability, hence, very few have similar operational business goals (Christiansen and Gotze, 2007). Only 30 percent of the governments with NEA programs are able to report clear quantitative goals in relation to their NEA effort (Christiansen 2006). NEA program has to be build according to the strategic goals of the government and both the short term and in particular the long term goals need to be defined. The key to a successful NEA program is a road-map describing the steps to achieve the short term goals (Ashmore et al., 2004).

The viewpoint of politics, actors and structures is very important in the governmental programs. According to Janssen and Hjort-Madsen (2007) NEAs can be guided and initiated at the political level or by public managers. They also state that the structure of the public administration determines the way NEA programs can be designed, disseminated and adopted.

Governance

Architectures evolve over time and consequently governance structures and mechanisms are important to guide and encourage desired behaviour (Janssen and Hjort-Madsen, 2007). If NEA lacks governance it decays over time when e.g. information systems change. According to Christiansen and Gotze (2007) 18 percent of governments have legislation to mandate their NEA programs and 46 percent have reported that their NEA programs are populated as a proposed practice.

Many of the barriers against the achievement of NEA goals are well known barriers towards the success in, e.g. traditional systems development. These barriers are relating to top management support, difficulties in finding skilled staff, the need of specific guidelines, issues regarding integration, planning issues, and proprietary technologies etc. (Christiansen 2006) It is somewhat surprising that these same barriers continue to occur from year to year. Governance models are one device for avoiding the obvious risks.

Architecture frameworks and methodologies

Christiansen and Gotze (2007) state that 82 percent of the governments have publicized NEA frameworks and 72 percent have publicized NEA processes, hence the level of detail varies substantially. In the EA field architecture

frameworks are perhaps the most studied area and there are several EA frameworks. One of the most influential frameworks is the Zachman (1987) framework. An introduction that covers many of the known frameworks can be found from Schekkerman (2003). The chosen models determine what aspects can be captured in the NEA and what level of abstraction is used (Janssen and Hjort-Madsen, 2007).

EA commonly has four viewpoints: business architecture, information architecture, application architecture and technology architecture. These viewpoints are promoted in many widely used frameworks such as FEA (2002), TOGAF (2003), and E2AF (2005). We have added the definition of the NEA to this viewpoint. It is important since the governments can have different definitions for the term NEA. Some governments use the term NEA for dispersed e-government projects and some might have a narrow view of NEA by focusing on, for example, technology architecture.

Architecture principles and standards

Architectural principles are statements that describe the constraints imposed upon the organisation, and the decisions taken in support of realizing the business strategies. Architectural descriptions can form the basis for the implementation and transformation of existing NEA into the desired architecture. (Janssen and Hjort-Madsen, 2007)

In this viewpoint we want to emphasise compatibility with the international standards, such as the European Interoperability Framework, EIF (IDABC, 2004). Today there is a growing need to advance interoperability between countries. International standards can be seen as important guidelines for NEA programs. For example the EU member states should follow instructions given in EIF in their own NEA work.

Implementations

Implementation is the use and translation of the NEA models and principles to the situation of public agencies (Janssen and Hjort-Madsen, 2007). This viewpoint provides indications for how the NEA is adopted, used and updated. It contains change support to enable the adoption and diffusion of the NEA and includes the development and use of central facilities and infrastructures. (Janssen and Hjort-Madsen, 2007)

NEA programs goals are not achieved only through planning, hence they are achieved through implementing the visions identified through the planning effort. The implementation, whether this includes business process reengineering, system implementation or both, is an essential part of the NEA. (Christiansen, 2006)

Benefits

Governments need to show positive effects of NEA efforts to be able to continually justify expending resources on NEA (Morganwalp and Sage, 2004). 45 percent of governments that have NEA program are measuring their program's performance. The same percentage is using key performance indicators (KPIs) in their NEA work. Only 18 percent of governments with NEA programs measure its total expenditures, the total amount gained from the NEA and the benefits to cost ratio. This indicates low maturity of NEAs. (Christiansen and Gotze 2007)

Possible benefits of NEA are presented in Christiansen (2006). They are for example decrease in used platforms and systems, and cost savings through shared infrastructure and services. The most challenging aspect of measuring the payback of NEA is to identify, measure, and monetize its economic benefits (Rico, 2005). NEA programs offer many types of benefits to a government and they can be distilled in five categories (IAB, 2003): 1) financial, 2) economic development, 3) reduced redundancy, 4) fostering democratic principles, and 5) improved service to citizens and other constituencies. Financial improvement means reducing the costs of organisations and enhancing revenue collection. Economic development means growing of the local, state, and federal economies. Reduced redundancy means consolidating, reducing, and integrating government systems. Fostering democracy means offering a consistent level of customer service to all stakeholders, regardless of political affiliation. Finally, constituent services mean improved services to citizens, customers, and all other key stakeholders. (IAB 2003, Rico 2005) Successful NEA program should address at least one of mentioned areas, but the most successful will probably deliver benefits in multiple ways (IAB, 2003).

Evaluation

Essential viewpoint for comparing NEAs is evaluation of the programs. Like measuring the benefits, the evaluation of NEA programs is many times missing. Some evaluations of different NEAs can be found from the academic community (e.g. Janssen and Hjort-Madsen 2007). Evaluation of different countries NEA programs can be helpful when a government is advancing its own NEA program or considering of establishing one. Countries should also evaluate their own programs to be able to get full benefits from the work done and developing their NEA further.

NEA Work in the Scandinavia

In this section we evaluate the distinct NEA programs or e-government initiatives of the Scandinavian countries. Unfortunately there are only few academic articles

on the subject and therefore the evaluation is mainly done on the basis of the government's Internet pages and reports. The author has participated in the work of a sub project of the Finnish Interoperability programme by attending the workshops of the Architecture Governance Model Project and another member of our research project has observed the EA Method Project. Next we evaluate the countries in alphabetical order.

Finland

Since the 1990s Finland has been a leader in exploiting ICT to renew its economy and to reform its public administration (OECD, 2003). Finland's Information Society Programme aims at boosting competitiveness and productivity, to promote social and regional equality and to improve citizens' well-being and quality of life through effective utilisation of information and communications technologies in the entire society. (Information Society Programme, 2007) Finland aims towards cutting costs through harmonization and using the savings for the overall development of the information society (Information Society Programme, 2005) First part of the Information Society Programme will end in April 2007 (Information Society Programme, 2007).

Finland has made two changes in the legislation to support the whole-of-government efforts. The new amendments of the law on openness of the government state that government organisations must make sure that their ICT systems comply with the technical requirements for interoperability and must take part in a shared customer service system, if so is required in a statute. The new amendments of the budget state that ministry of Finance can order government organisations to use the joint procurement contracts negotiated by the state central procurement unit. (Terho, 2006)

Within the Information Society Program are the governments ICT development programmes. A program to reform state information management was launched and the state IT management unit was established in the Ministry of Finance in spring 2005 (Information Society Programme, 2007). Development of ICT operations aims at building prerequisites for customer-oriented flexible services and strengthening transparency of the administration. Government's decision in principle includes government's ICT operations long term objectives, strategies in development of the ICT functions, common governance model and the development programmes for the years 2006-2011. (Ministry of Finance, 2006b) One of the five programmes is called interoperability.

The interoperability programme develops interoperability of the ICT systems of the state administration, decreases overlap in information collection and maintenance as well as the number of overlapping ICT systems. The main goal is to increase flexibility. The programme aims at creation of the common state ICT architecture (the Finnish NEA), which will be used as a tool to develop functions and ICT systems at all levels of state administration. For maintaining the

architecture and to utilising the descriptions of the architecture in the steering of projects and the planning of systems a governance model will be introduced. (Ministry of Finance, 2006a) Planning of the architecture is finished by the end of the year 2007. After that the NEA will be implemented, spread in the government agencies and the governance model will be established. Interoperability programme goes on until the year 2011. The State IT Management Unit is the organisation responsible of the programme. (Ministry of Finance, 2006c)

Several government organisations have already started to work within the EA area, but in the level of state government the big picture is missing. This makes it necessary to aggregate and standardise the information of the information systems, technology solutions and existing architectural and operational descriptions. Focus is on shared information systems, common basic technology, shared services and cross-public sector processes. (Ministry of Finance, 2006d) Currently, government and municipalities have their own development programs for the ICT functions but these will be united in 2009 (Terho, 2006)

Finnish NEA consists of the descriptions of the business, information, application and technology architectures realised with the common description languages and methods. NEA method is in accordance with the TOGAF process and NEA utilises known frameworks (such as EIF, FEAF, TOGAF and NAF) in reference models and architecture descriptions (EA Method Project, 2007a). At the governmental level the NEA is in accordance with EIF (EA Method Project, 2007b) and in the cost-benefit analysis model adopts the FEA's (FEA, 2002) Performance reference model (Architecture Governance Model Project 2007a). Within the NEA the current state, target state and the road-map are described. For the evaluation of the current state a maturity model is used. The model is based on the common CMM (capability maturity model) and the NASCIO models (Architecture Governance Model Project 2007b). It is essential to form an overall picture of the architecture in the level of the state government and depicting the architecture of every agency (Ministry of Finance, 2006d). Hence, the governance model will include process and organisation descriptions and the maintenance model for the NEA. To conclude, Finnish NEA includes EA framework, EA descriptions and the governance model.

The Finnish NEA is in the planning phase and it should be ready by the end of June 2007. Pilot implementations will start by the second quarter of the year 2007. Currently there is not a comprehensive model for the analysis of the benefits of the whole NEA program. One of the main challenges is the ownership of the NEA and its processes. The key to a successful NEA program is in this point at the well planned and executed implementation. On the positive side is that the NEA approach is holistic. Analysis of the Finnish NEA is summarised in the Table 2.

	Finland
1. Policies, actors and structures	NEA is developed by the Ministry of Finance. Project is formed as a cross-public sector project. Council of State has recognised 1) shared information systems, 2) common basic technology, 3) shared services, and 4) cross-public sector processes as the key focus areas.
2. Governance	The governance model will be finished in May 2007.
3. Architecture frameworks and methodologies	NEA model will be ready in April 2007. The framework covers four common viewpoints (business, information, application and technology architectures). NEA method is in accordance with the TOGAF process. NEA utilises known frameworks (such as EIF, FEAF, TOGAF and NAF) in reference models and descriptions.
4. Architecture principles and standards	NEA includes maturity model that is based on the CMM and NASCIO models. In the governmental level the NEA is in accordance with EIF. In cost-benefit analysis the FEA's Performance reference model is adapted.
5. Implementations	Implementation plan will be ready in May 2007.
6. Benefits	A cost-benefit analysis model is included in the NEA.
7. Evaluation	At this point one of the main challenges is the ownership of the NEA and its processes. For the NEA to be successful the implementation phase needs to be successful.

Table 2. Evaluation of the Finnish NEA program

Denmark

The Danish government is pursuing a vigorous e-government programme spanning the whole of the public sector. Many international assessments of countries' e-government achievements have consistently ranked Denmark as one of the leading e-government nations. (OECD, 2005a) In the beginning of the 21 century Denmark was one of the few governments with a NEA program (Schekkerman 2004). The Danish NEA work is intended to improve the basic conditions for efficient and coherent public ICT use. The NEA is expected to enable optimisation of the value of government's ICT investments, minimisation of the risk of individual projects, and creation of a more flexible and competitive ICT market (OECD, 2005a). Work includes the drafting of general guidelines and principles for building ICT systems in the public sector (common enterprise architecture) and dissemination of standards for data interchange.

The Danish NEA is developed under the Ministry of Science, Technology and Innovation in strong collaboration with Danish municipalities and the Ministry of Finance (Janssen and Hjort-Madsen, 2007). The white paper of the Ministry of

Science, Technology and Innovation (2003) proposed five core architectural principles: 1) interoperability, 2) security, 3) openness, 4) flexibility, and 5) scalability. To give effect to these it was recommended that the government adopts a service-oriented architecture (SOA) model based on various international standards. The SOA model treats individual ICT solutions as modularly designed services with well-defined interfaces with each other and to legacy systems. (OECD, 2005a) The NEA governance model is based on incentives and there is no legislation or regulations dictating the NEA adoption, hence, agencies are free to design their own architecture (Janssen and Hjort-Madsen, 2007).

In the year 2006 the Danish parliament decided upon advancing the use of open standards (so-called Parliamentary decision B103). It imposes on the government a duty to ensure that the public sector's use of ICT, including use of software, is based on open standards. The government should adopt and maintain a set of open standards at the beginning of the year 2008, or as soon as technically possible. Open standards should be part of the basis for the public sector's development and procurement of ICT software. The government will ensure that all digital information and data that the public sector exchanges with citizens, companies and institutions, is available in open standards-based formats. (ICA, 2006a) The Danish Interoperability Framework has been compiled in accordance with the EIF and offers a set of policies, technical standards and guidelines that outlines the government's policy on how to achieve interoperability. The Danish framework is targeted at any authority that request to interoperate with other national authorities or abroad with the EU and its member countries. (Danish e-Government Interoperability Framework, 2005)

Danish NEA is called OIO (Offentlig Information Online) Architecture, it covers the joint public work within e-government architecture and standardisation. OIO Architecture is a common framework that contains overall principals, methods, tools, and control frameworks, in addition, it is the embodiment of a concrete architecture including selection of standards, reference model design, establishment of common infrastructure elements, etc. (Ministry of Science, Technology and Innovation, 2006) The NEA model is based on the Zachman framework, but the primary focus is on planning process (Janssen and Hjort-Madsen, 2007) Denmark has a standardization guide that documents common ICT, technical, data and process standards (ICA, 2006a).

According to OECD (2005a) the Danish e-government faces a range of challenges that include: 1) maintaining momentum during a time of major restructuring of responsibilities across levels of government, 2) increasing government organisations' awareness and understanding of the purpose and scope of the e-government programme, 3) developing more collaboration over e-government between agencies and across levels of government, and 4) striking the right balance between centralised co-ordination and decentralised

implementation of e-government. Christiansen (2006) states that Denmark has reported conceptual goals and publicised guidelines describing an EA process and is developing an EA tool to store and share NEA knowledge. He continues that Denmark has not been able to report any achieved goals and only carries out limited measurement that for example does not give knowledge about the actual use ratio.

Janssen and Hjort-Madsen (2007) have done an exhaustive evaluation of the NEA programs in Denmark and Netherlands. They state that the Danish NEA focuses mainly on interoperability. This requires a strong governance model that is lacking in Denmark. Danish NEA has faced the risk of failure in the implementation phase. There are problems in creating the NEA comprehensive and understandable. The architectural models are perceived difficult, too abstract and therefore only used to provide structure to the NEA efforts. (Janssen and Hjort-Madsen, 2007) Analysis of the Danish NEA is summarised in the Table 3.

	Denmark
1. Policies, actors and structures	Responsible ministry of the NEA initiatives is the Ministry of Science, Technology and Innovation. Collaboration with Danish Municipalities and the Ministry of Finance. The focus is on 1) interoperability, 2) security, 3) openness, 4) flexibility, and 5) scalability.
2. Governance	NEA governance model is based on the incentives. NEA adoption is not dictated by law or regulations.
3. Architecture frameworks and methodologies	NEA includes principals, methods, tools, and control frameworks The NEA model is based on the Zachman framework.
4. Architecture principles and standards	NEA includes selection of standards, reference model design, establishment of common infrastructure elements, etc. Strong emphasis on open standards and a set of open standards will be available in 2008. Interoperability framework is compiled in accordance with EIF.
5. Implementations	Dominant SOA orientation, but no systematic development and implementation of standard building blocks.
6. Benefits	Conceptual goals have been reported, but no reports on achieved goals and only limited measurement.
7. Evaluation	An advanced NEA program that takes interoperability as a starting point. Unfortunately a strong governance model is missing. Problems in the implementation of the NEA.

Table 3. Evaluation of the Danish NEA program

Norway

Norway has long been actively using ICT at the public sector, which has provided it with an important tool for achieving gains in government efficiency, for improving the quality of public services and for modernising government. In developing electronic services for citizens Norway is average within the EU countries. The challenge for Norway is to exploit the well-integrated government-wide technology and at the same time respect the tradition of a decentralised, consensus-based government. (OECD, 2005b) E-government development in Norway has been strongly influenced by EU initiatives, even though Norway is not an EU member (OECD, 2005b).

The Ministry of Government Administration and Reform (2007) is responsible for the Norwegian national policy for development and co-ordination of the use of ICT and measures to make the government more efficient and service-oriented. According to the Ministry of Government administration and reform (2006) its co-ordinating mandate is limited. The government's information society policy focuses on 1) strengthening Norway's leadership in ICT development, 2) using ICT to promote economic and social development and 3) making the benefits of the information society available to all (OECD, 2005b). Interaction between different actors in the public sector could be improved. Each government organisation is responsible for its own procurements and development of ICT solutions. This has resulted in scarcely co-ordinated e-services. (Ministry of Government administration and reform, 2006)

Norway has a well-established e-government central vision and strategy. However, there are no general requirements for e-government planning within individual ministries and agencies, and it is up to each ministry and agency to translate the common vision into concrete plans. Broad national e-government objectives have not been sufficiently translated into clear targets and goals for ministries and agencies. (OECD, 2005b) The Norwegian government has been successful in developing the necessary online frameworks, which enhance cross-public sector collaboration and exchange of e-government implementation experiences (OECD, 2005b) With eNorway (Ministry of Trade and Industry, 2001), the government has been successful in setting up a framework for measuring progress in the development of the information society but there is no whole-of-government framework for monitoring progress and assessing the impact of e-government initiatives (OECD, 2005b).

The Norwegian e-government aims at an open, accessible and coherent public sector offering integrated and fully digital services and to rationalise and free up resources through the use of ICT. The government will base its software policy on open standards and more extensive use of open source software. (Ministry of Government administration and reform, 2006)

The Ministry of Government administration and reform (2006) has set the Norwegian NEA as a goal. The NEA will be layered and will consist at least of a

presentation layer, a common component layer and an enterprise layer. Before the end of 2007, a more detailed description of the architecture principles with associated strategies and guidelines will be prepared. When the NEA is in operation, major public ICT projects must be based on and support the NEA. (Ministry of Government administration and reform, 2006)

NEA will include three kind of ICT standards. Technical standards, which make it possible for different systems to exchange data. Conceptual (semantic) standards, which ensure that the data is always interpreted similarly. Organisational and procedural standards, which mean that interacting parties have explicit divisions of responsibility and process descriptions. Standards will be assigned a graded status, such as recommended or mandatory for use in the public sector. In order to achieve more effective electronic transactions and to avoid having to develop complex solutions more often than necessary, there is a need to establish a number of shared public sector ICT infrastructure components. (Ministry of Government administration and reform, 2006) The government will make a governance model that will give guidance on how the NEA works, the establishment of shared components, further work on administration standards etc. is going to be organised, managed and financed. (Ministry of Government administration and reform, 2006)

Norway seems to be in a way to establish NEA. The work has begun only recently and this makes evaluation fairly fruitless. After some time there will be more knowledge available from the NEA program. Analysis of the Norwegian approach is summarised in the table 4.

	Norway
1. Policies, actors and structures	The Ministry of Government Administration and Reform is responsible of the ICT development and strategy.
2. Governance	NEA will include a governance model.
3. Architecture frameworks and methodologies	NEA will be based on a layered model (presentation layer, a common component layer and an enterprise layer). NEA model will be ready by the end of the year 2007.
4. Architecture principles and standards	Heavy emphasis on open standards and open software. NEA includes technical standards, conceptual standards, and organisational and procedural standards. NEA will include a shared component library.
5. Implementations	
6. Benefits	
7. Evaluation	NEA work has recently begun.

Table 4. Evaluation of the Norwegian approach

Sweden

Swedish public administration is currently undergoing a change towards dynamic model of governance. It aims at high level of interoperability between governmental organisations and quality of service for citizens and companies depending on the services provided by the government. Swedish vision (Statskontoret, 2005) of the 24-hour government is to be realized through the application of web-service based technology, resulting in a SOA. (Magnusson and Nilsson, 2006)

Verva, the Swedish Administrative Development Agency, is responsible for co-ordinating the development of central government in Sweden and is one of the government's central advisory agencies (Verva, 2006). Verva has a stated responsibility for promoting e-government services (ICA, 2006b). Only limited coordination of ICT projects has existed between different ministries and governmental bodies (Ilshammar, Bjurström and Grönlund, 2005) In Sweden e-government projects are seen as parts of the normal service and administrative development, therefore each administrative body is responsible for its own e-government projects and there is no special investment facility. There is no e-government specific legislation. (ICA, 2006b)

In June 2006 the Swedish government presented its new strategy for the development of e-government. It aims at higher efficiency and effectiveness in public administration, and at improving the service for citizens and businesses. The Swedish government has set four main targets in the strategy: 1) A more efficient and effective information management by 2010, 2) Quicker and more secure administrative process through use of information technology by 2010, 3) Electronic processes for public purchases by 2010, and 4) A common government policy for secure electronic communication. Through the strategy, the government is strengthening its governance concerning the development of public administration based on ICT. (ICA, 2006b) Better services, democracy, etc. have been frequently on the Swedish e-government agenda but rationalisation is the dominating goal (Ilshammar, Bjurström and Grönlund, 2005).

In an international EA activities study of sixteen governments Christiansen (2006) found out that Sweden is the only country that does not have any plans for incorporating a national EA program. Also Ilshammar, Bjurström and Grönlund (2005) state Sweden has chosen an unstructured form of development. Lundgren (2003) has reported that Sweden has the lowest degree of political control among comparable countries studied, and that in international comparisons Sweden is unique in not having produced measurable goals for its ICT policy. Lundgren proposes that Swedish ICT policy should incorporate a long-term perspective and focus on strategic problem areas in the society. The political focus is too often on the producers of e-services, the public administration and the ICT-industry, not on the citizens (Ilshammar, Bjurström and Grönlund, 2005).

The Swedish government has expressed that the old ways of agencies acting as isolated silos will have to change (Ilshammar, Bjurström and Grönlund, 2005). The Swedish Administrative Development Agency, Verva has done a feasibility study of architecture and framework for interoperability. The study discusses development of common specification, and ongoing architecture initiatives in Sweden and in other countries. The study proposes goals for Swedish NEA reference model and suggests three matters to be defined: 1) main operations, 2) requirements and prerequisites from EU for Swedish national work, and 3) architecture model, framework and strategy. (Wessbrandt, 2006) It seems that Sweden is considering the possibility of introducing a NEA program but has not yet established one.

Analysis of the Swedish e-government work is summarised in the Table 5, although Sweden currently does not have a NEA. Evaluation is made to be able to compare the Scandinavian countries.

	Sweden
1. Policies, actors and structures	Verva, the Swedish Administrative Development Agency, is responsible for co-ordinating the development of central government in Sweden.
2. Governance	Each administrative body is responsible for its own e-government projects.
3. Architecture frameworks and methodologies	A feasibility study is made to survey the possibilities of the NEA program. No concrete NEA initiative.
4. Architecture principles and standards	A feasibility study is made to survey the possibilities of the NEA program. No concrete NEA initiative.
5. Implementations	
6. Benefits	There are not concrete measurements for the success of e-government projects.
7. Evaluation	Currently there are disconnected e-government projects without a central governance facility. The possible benefits of the NEA are not achieved.

Table 5. Evaluation of the Swedish e-government

Concluding Remarks

There is a trend towards the whole of government vision in governments through centralization, enterprise architectures and integrated services (ICA, 2006c). The development and implementation of a cohesive ICT policy is seen as necessary for further development of the information society (Ministry of Government administration and reform, 2006). In governance, there is a wave of government-wide strategies that promote centralization and cross-government and cross-

public sector collaboration (ICA, 2006c). These trends are visible in the evaluation of the Scandinavian countries' NEA programs.

The Scandinavian countries have similarities and differences in their development approaches. Denmark is the frontrunner in NEA. Danish NEA program is fairly comprehensive and implementation is ongoing. Finland is quickly advancing NEA and implementations in pilot projects are starting. Norway has begun a NEA program and a NEA model will be ready this year. Sweden is considering about starting a NEA program. Denmark and Norway are heavily promoting for open standards and systems. Finland and Sweden have not made statements in this matter. Denmark and Sweden have adopted SOA in service design. Norway will establish a shared component library. Following development in these aspects will be interesting.

The study raises some interesting questions for further study. The results of this study are mainly based on literature. It would be beneficial to have a more profound view into the NEA programs, for example, by interviewing people participating in the NEA work in different countries. It would also be interesting to take wider selection of countries. On possibility would be constructing possible further developments of the different NEA programs. Interesting research topic would be comparing the EA work in the private sector to the NEA work.

Acknowledgements

The author would like to thank the FEAR project (www.jyu.fi/titu/fear) for funding this work. I also thank the three anonymous reviewers for their constructive comments.

References

- Accenture (2006) Leadership in Customer Service –Building the Trust. Available online at [last viewed 26.2.2007] <http://www.accenture.com/xdoc/en/industries/government/acn_2006_govt_report_FINAL2.pdf>.
- Andersen, K.V., Grönlund, Å., Moe, C. E., and Sein, M. K. (2005) Introduction to the Special Issue, E-Government in Scandinavia. *Scandinavian Journal of Information Systems*, vol. 17, no. 2, 3–10.
- Architecture Governance Model Project (2007a) Valtionhallinnon yhteentoimivuuden kehittämisohjelma - valtionhallinnon arkkitehtuurin suunnittelu – hanke, Toiminta- ja ohjausmallin kehittäminen –projekti, Arkkitehtuurikyvykkyyden hyöty/kustannustekijä – analyysi, Raportti, Versio 0.81. Ministry of Finance, Finnish Government's Architecture Project, Operations and Governance Model Project. Unpublished document n Finnish.

- Architecture Governance Model Project (2007b) Valtionhallinnon yhteentoimivuuden kehittämisohjelma - valtionhallinnon arkkitehtuurin suunnittelu – hanke, Toiminta- ja ohjausmallin kehittäminen –projekti, Arkkitehtuurikyvykkyyden kypsyystasomalli, Ohje, Versio 0.81. Ministry of Finance, Finnish Government's Architecture Project, Operations and Governance Model Project. Unpublished document n Finnish.
- Ashmore, P., Henson, J., Chancellor, J., and Nelson, M. (2004) Is Your Enterprise Architecture All It Can Be? Lessons From the Front-Line. Business Process Trends, May 2004. Available online at [last viewed 26.3.2007] <<http://www.bptrends.com/publicationfiles/06%2D04%20ART%20Is%20Your%20EA%20All%20It%20Could%20Be%20%2D%20Nelson%20et%20al%2Epdf>>.
- Cap Gemini Ernst & Young (2003) *Online Availability of Public Services: How Does Europe Progress*. Report for the European Commission, DG Information Society. Available online at [last viewed 26.2.2007] <<http://www.capgemini.com/news/2003/egovfull.zip>>.
- Christiansen, P. E. (2006) *International Enterprise Architecture survey - Trends in governmental Enterprise Architecture on a national level*. Master's thesis. IT University of Copenhagen.
- Christiansen, P. E., Gotze, J. (2006) *International Enterprise Architecture survey - Trends in governmental Enterprise Architecture on a national level*. Available online at [last viewed 26.3.2007] <http://easurvey.org/06_easurveyreport_ver01.pdf>.
- Christiansen, P. E., Gotze, J. (2007) Trends in Governmental Enterprise Architecture: Reviewing National EA Programs – Part 1. *Journal of Enterprise Architecture*, vol. 3, no. 1, 8-18.
- Coe, A., Paquet, G. and Roy, J. (2001) E-Governance and Smart Communities – A Social Learning Challenge. *Social Science Computer Review*, vol. 19, no. 1, 80-93.
- Dalziel, D. (2004) *Government Online: A Multi-Country Study of E-Government Usage*. The World Association of Research Professionals, ESOMAR Report. Available online at [last viewed 26.3.2007] <<http://www.tns-global.com/corporate/Doc/0/JHPECQDD94195MMQEC0/GovernmentOnline>>
- Danish e-Government Interoperability Framework (2005) *About the Interoperability Framework*. Release 1.2 - June 2005. Available online at [last viewed 20.3.2007] <<http://standarder.oio.dk/English/Guidelines/>>.
- E2AF (2005) Extended EnterpriseArchitecture Framework (E2AF). Institute For Enterprise Architecture Developments (IFEAD). Version 1.4 available online at [last viewed 20.2.2007] <<http://www.enterprise-architecture.info/Images/E2AF/E2AF%20A0%20New%20Poster%203-2005%20version%201.4.pdf>>.
- EA Method Project (2007a) Valtionhallinnon arkkitehtuurin suunnittelu, Valtiovarainministeriö, Arkkitehtuurimenetelmä, kuvaustavat ja arkkitehtuurin sisältö, EA-menetelmä- ja -kehysvaihtoehdot ja niiden vertailu. Ministry of Finance, Finnish Government's Architecture Project, EA Method Project. Unpublished document n Finnish.
- EA Method Project (2007b) Valtionhallinnon yhteentoimivuuden kehittämisohjelma, Arkkitehtuurin suunnittelu, kokA – menetelmä, Ohje, Versio 0.8. Ministry of Finance, Finnish Government's Architecture Project, EA Method Project. Unpublished document n Finnish.
- FEA (2002) *Federal Enterprise Architecure (FEA)*. Office of Management and Budget (OMB). Available online at [last viewed 20.2.2007] <<http://www.whitehouse.gov/omb/egov/a-1-fea.html>>.
- Flak, L.S., Rose J. (2005) Stakeholder Governance: Adapting Stakeholder Theory to E-Government. *Communications of the Association for Information Systems*, vol. 16, 662-664.

- Flak, L.S., Olsen, D. H. , and Wolcott, P. (2005) Local E-Government in Norway: Current Status and Emerging Issues. *Scandinavian Journal of Information Systems*, vol. 17, no. 2, 41-84.
- GAO (2002) *OMB Leadership Critical to Making Needed Enterprise Architecture and E-government Progress*. United States Government Accountability Office (GAO), GAO-02-389T. Available online at [last viewed 26.3.2007] <<http://www.gao.gov/new.items/d02389t.pdf>>.
- GAO (2004) *The Federal Enterprise Architecture and Agencies' Enterprise Architectures Are Still Maturing*. United States Government Accountability Office (GAO), GAO-04-798T. Available online at [last viewed 26.3.2007] <<http://www.gao.gov/new.items/d04798t.pdf>>.
- GAO (2006) *Leadership Remains Key to Establishing and Leveraging Architectures for Organizational Transformation*. United States Government Accountability Office (GAO), GAO-06-831. Available online at [last viewed 26.3.2007] <<http://www.gao.gov/new.items/d06831.pdf>>.
- Hjort-Madsen, K. (2006) Enterprise Architecture Implementation and Management: A Case Study on Interoperability. *Proceedings of the 39th Annual Hawaii International Conference on System Sciences*, HICSS 39, Jan 4-7, Kauai, Hawaii.
- Hjort-Madsen, K., Burkard, J. (2006) When Enterprise Architecture Meets Government: An institutional case study analysis. *Journal of Enterprise Architecture*, vol. 2, no. 1, 11-25.
- Hjort-Madsen, K., Gotze, J. (2004) Enterprise Architecture in Government – Towards a multi-level framework for managing IT in government. In *Proceedings of ECEG04*, Dublin, Ireland, 365-374.
- Ho, A. T. K. (2002) Reinventing Local Governments and the E-Government Initiative. *Public Administration Review*, vol. 62, no. 4, 434-444.
- IAB (2003) *High payoff in electronic government: Measuring the Return on E-Government Investment*. United States Intergovernmental Advisory Board, Federation of Government Information Processing Councils, May 2003. Available online at [last viewed 26.3.2007] <http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/High%20Payoff_R2F-aQX_0Z5RDZ-i34K-pR.pdf>.
- ICA (2006a) ICA - Country Report from Denmark –ICA Conference 2006. In *Proceedings of the 40th International Council for Information Technology in Government Administration Conference*, ICA 40th, September 12 -14, Guadalajara, Mexico.
- ICA (2006b) ICA Country Report - Sweden 2006. In *Proceedings of the 40th International Council for Information Technology in Government Administration Conference*, ICA 40th, September 12 -14, Guadalajara, Mexico.
- ICA (2006c) The Status of Information and Communication Technologies (ICT) in Governments – 2006: An Analysis of ICA Country Reports for the 40th Annual ICA Conference. In *Proceedings of the 40th International Council for Information Technology in Government Administration Conference*, ICA 40th, September 12 -14, Guadalajara, Mexico.
- IDABC (2004) *European Interoperability Framework For Pan-European Egovernment Services*. Interoperable Delivery of European eGovernment Services to public Administrations, Businesses and Citizens, IDABC. Version 1.0 available online at [last viewed 26.3.2007] <<http://ec.europa.eu/idabc/servlets/Doc?id=19528>>.
- Ilshammar, L., Bjurström, A., and Grönlund, Å. (2005) Public E-Services in Sweden: Old Wine in New Bottles? *Scandinavian Journal of Information Systems*, vol. 17, no. 2, 11-40.
- Information Society Programme (2007) *The Government gave new impetus to Finland's information society development*. Press release 6.2.2007 of Prime Minister's Office. Available online at [last viewed 1.4.2007] <http://www.tietoyhteiskuntaohjelma.fi/ajankohtaista/news/en_GB/181919/>.

- Information Society Programme (2005) *Government IT services*. Available online at [last viewed 1.4.2007] <http://www.tietoyhteiskuntaohjelma.fi/osa-alueet/jukishallinnon_sahkoiset/en_GB/government_it_services/>.
- Janssen, M., Hjort-Madsen, K. (2007) Analyzing Enterprise Architecture in National Governments: The cases of Denmark and the Netherlands. *Proceedings of the 40th Hawaii International Conference on System Sciences*, HICSS 40, Jan 3-6, Waikoloa, Big Island, Hawaii.
- Janssen, M., Kuk, G. (2006) A Complex Adaptive System Perspective of Enterprise Architecture in Electronic Government. *Proceedings of the 39th Annual Hawaii International Conference on System Sciences*, HICSS 39, Jan 4-7, Kauai, Hawaii.
- Kawalek, P., Wastell, D. G., and Newman, M. (2003) Problematisation and Obfuscation in E-Government, in R. Traunmüller (ed.), *Electronic Government*, Proceedings of the Second International Conference EGOV 2003, Prague, Czech Republic, September 1-5, 2003 Springer Verlag, Berlin, 228-233.
- Langenberg, K., Wegmann, A. (2004) *Enterprise Architecture: What Aspects is Current Research Targeting?* EPFL Technical Report IC/2004/77. Available online at [last viewed 2.4.2007] <http://ic2.epfl.ch/publications/documents/IC_TECH_REPORT_200477.pdf>.
- La Porte, T. M., Demchak, C. C. and de Jong, M. (2002) Democracy and Bureaucracy in the Age of the Web - Empirical Findings and Theoretical Speculations. *Administration & Society*, vol. 34, no. 4 , 411-446.
- Layne, K., Lee, J. W. (2001) Developing Fully Functional E-Government: A Four Stage Model. *Government Information Quarterly*, vol. 18, no. 2, 122-136.
- Lundgren, K. (2003) *A Learning ICT Policy for Growth and Welfare*. ITPS Final Report on its Assignment of Evaluating the Swedish ICT policy, ITPS report A2003:015, ITPS, Östersund.
- Magnusson, J., Nilsson, A. (2006) Infusing an Architectural Framework with Neo-institutional Theory -Reports from recent change management initiatives within the Swedish Public Administration. *Proceedings of the 39th Annual Hawaii International Conference on System Sciences*, HICSS 39, Jan 4-7, Kauai, Hawaii.
- Ministry of Finance (2006a) *Government Policy Decision on the Development of IT Management in State Administration*. Publications of Ministry of Finance; Finland, Public Management Department 3c/2006. Available online at [last viewed 1.4.2007] <http://www.vm.fi/vm/en/04_publications_and_documents/03_documents/Vnpp_engl_lyhyt.pdf>.
- Ministry of Finance (2006b) Valtion IT-kehittämisohjelmat. In Finnish. Available online at [last viewed 1.4.2007] <http://www.vm.fi/vm/fi/05_hankkeet/011_IT_ohjaus/index.jsp>.
- Ministry of Finance (2006c) Valtionhallinnon arkkitehtuurin suunnittelu –hanke. In Finnish. Available online at [last viewed 1.4.2007] <http://www.hare.vn.fi/mHankkeenTaustatietojenSelailu.asp?h_iID=12260&tVNo=2&sTyp=Selaus>.
- Ministry of Finance (2006d) Yhteentoimivuuden hankkeet. In Finnish. Available online at [last viewed 1.4.2007] <http://www.vm.fi/vm/fi/13_hallinnon_kehittaminen/06_yhteentoimivuus/01_hankkeet/index.jsp>.
- Ministry of Government Administration and Reform (2007) The Ministry of Government Administration and Reform, Norway. Available online at [last viewed 1.4.2007] <<http://www.regjeringen.no/en/dep/fad.html?id=339>>.
- Ministry of Government Administration and Reform (2006) *An Information Society for All*. Summary in English: Report No. 17 (2006–2007) to the Storting. The Ministry of Government Administration and Reform, Norway.

- Ministry of Science, Technology and Innovation (2006) *Strategy for OIO Architecture for e-Government 2006-10*. Ministry of Science, Technology and Innovation, Denmark.
- Ministry of Science, Technology and Innovation (2003) White Paper on Enterprise Architecture. Working Group on IT Architecture within the Coordinating Information Committee, Ministry of Science, Technology and Innovation, Denmark. Available online at [last viewed 19.3.2007] <<http://www.oio.dk/files/whitepaper.pdf>>.
- Ministry of Trade and Industry (2001) *eNorway 3.0*. Ministry of Trade and Industry, Norway. Available online at [last viewed 1.4.2007] <<http://www.regjeringen.no/en/dep/nhd/Ryddemappe/nhd/english/doc/plans/eNorway-30.html?id=412010>>.
- Morganwalp, J. M., Sage, A. P. (2004) Enterprise Architecture Measures of Effectiveness. *International Journal of Technology, Policy and Management*, vol. 4, no. 1, 81-94.
- Muir, A., Oppenheim, C. (2002) National Information Policy Developments Worldwide I: Electronic Government. *Journal of Information Science*, vol. 28, no. 3, 173-186.
- NASCIO (2004) NASCIO EA Assessment Tour Site Visit Report. National Association of State CIOs (NASCIO). Available online at [last viewed 26.3.2007] <http://www.ncsta.gov/docs%5CPresentations%5CNASCIO_EA_Assessment_Tour_Report_20041007.pdf>.
- Norwegian Ministry of Government administration and reform (2006) An Information Society for All. Summary in English: Report No. 17 (2006-2007) to the Storting. White paper Available online at [last viewed 26.3.2007] <http://www.regjeringen.no/upload/FAD/Vedlegg/IKT-politikk/stm17_2006-2007_eng.pdf>.
- OECD (2005a) *OECD Peer Review of E-Government in Denmark*. Organisation for Economic Co-operation and Development (OECD). Pre-Publication Draft: Version 2 – 29 September 2005. Available online at [last viewed 26.2.2007] <http://e.gov.dk/uploads/media/OECD_analyse_af_digital_forvaltning_i_Danmark_09-2005.pdf>.
- OECD (2005b) OECD E-Government Studies: Norway Assessment. Organisation for Economic Co-operation and Development (OECD). Executive summary available online at [last viewed 26.2.2007] <[http://webdomino1.oecd.org/COMNET/PUM/egovproweb.nsf/viewHtml/index/\\$FILE/Norway_exesum.pdf](http://webdomino1.oecd.org/COMNET/PUM/egovproweb.nsf/viewHtml/index/$FILE/Norway_exesum.pdf)>.
- OECD (2003) *OECD e-Government Studies: e-Government in Finland*. Organisation for Economic Co-operation and Development (OECD). Available online at [last viewed 26.2.2007] <[http://webdomino1.oecd.org/COMNET/PUM/egovproweb.nsf/viewHtml/index/\\$FILE/E-GOV%20FINLAND.pdf](http://webdomino1.oecd.org/COMNET/PUM/egovproweb.nsf/viewHtml/index/$FILE/E-GOV%20FINLAND.pdf)>.
- Peristeras, V., Tarabanis, K. (2004) Governance enterprise architecture (GEA): domain models for e-governance. In *Proceedings of the 6th international conference on Electronic commerce*. Delft, The Netherlands, ACM Press, 471-479.
- Rico, D. F. (2005) *A Framework for Measuring the ROI of Enterprise Architecture*. Available online at [last viewed 1.4.2007] <<http://davidfrico.com/rico05a.pdf>>.
- Ronaghan, S. A. (2002) Benchmarking E-Government: A Global Perspective –Assessing the Progress of UN Member States. United Nations Division for Public Economics and Public Administration Report, New York. Available online at [last viewed 26.3.2007] <<http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN021547.pdf>>.
- Schekkerman, J. (2005) *Trends in Enterprise Architecture 2005 – How are Organizations Progressing?* Institute for Enterprise Architecture Development (IFEAD). Available online at [last viewed 26.3.2007] <<http://www.enterprise-architecture.info/Images/EA%20Survey/Enterprise%20Architecture%20Survey%202005%20IFEAD%20v10.pdf>>.
- Schekkerman, J. (2003) *How to Survive in the Jungle of Enterprise Architecture Frameworks – Creating or Choosing an Enterprise Architecture Framework*. Trafford, Victoria, Canada.

- Statskontoret (2005) *Service, transparency and efficiency - Framework for assessing the performance of e-government in Sweden*. Statskontoret, Department for e-government. Available online [last viewed 26.3.2007] <<http://ec.europa.eu/idabc/servlets/Doc?id=2907>>.
- Terho, A. (2006) ICA Country Report, Finland. Ministry of Finance, State IT Management Unit. In *Proceedings of the 40th International Council for Information Technology in Government Administration Conference, ICA 40th*, September 12 -14, Guadalajara, Mexico.
- TOGAF (2003) *The Open Group Architecture Framework*. Version 8.1, Enterprise Edition available online at [last viewed 20.2.2007] <<http://www.opengroup.org/togaf>>.
- United Nations (2003) World Public Sector Report 2003: E-government Crossroads,” ST/ESA/PAD/SER.E/49, New York. Available online at [last viewed 26.3.2007] <<http://unpan1.un.org/intradoc/groups/public/documents/un/unpan012733.pdf>>.
- Watson, R. T. and Mundy, B. (2001) A Strategic Perspective of Electronic Democracy. *Communications of the ACM*, vol. 44, no. 1, 27-30.
- Verva (2006) *Verva -Swedish Administrative Development Agency*. Available online at [last viewed 26.3.2007] <http://www.verva.se/web/t/Page___492.aspx>.
- Wessbrandt, K. (2006) Arkitektur och ramverk för interoperabilitet – förstudie 2006. Verva – Verket för Förvaltningsutveckling, Missiv, diariennr 2006-10-02 2006/378. In Swedish. Available online at [last viewed 26.3.2007] <http://www.verva.se/upload/publikationer/2006/Forstudie_arkitektur_och_ramverk.pdf>.
- Zachman, J. A. (1987) A Framework for Information Systems Architecture. *IBM Systems Journal*, vol. 26, no. 3.

Competence Management Systems in Networking Organisations: Designing for Empowerment?

Ulrika Lundh Snis, Lena Pareto and Lars Svensson

Laboratorium for Interaction Technology

University West, Sweden

ulrika.snis@hv.se, lena.pareto@hv.se, lars.svensson@hv.se

Abstract. Current trends among business companies imply that sources of human competencies are spread across intra-organisational and inter-organisational units into networks of organisations of different kinds. This paper explores the challenges for design of competence management systems (CMS) raised by inter-organisational collaboration in a network of private companies. We take the point of departure from the co-workers' ability to explore and manage their competence. The research question to be answered is: How can a network perspective on competence management systems empower co-workers? The paper presents findings from an on-going research project aiming at identifying design implications of a network competence management system (nCMS), where the role of the individual is valued crucial for its success. We argue that there is a need to take a critical stand towards common assumptions of CMS as a tool for intra organisational strategic work - instead a nCMS should empower the individual member of the network organization.

Keywords. Competence management systems, inter-organisational collaboration, networking organisations, design implications, empowerment, nCMS.

Introduction

There is an on-going debate on human resource and its management that says that human capability should not only be seen as a resource among others, but as the

main source of improving performance and exploring competencies and innovation. This indeed also recall the previous change in how the organisational view has shifted from the old and restrictive notion of employee “qualifications”, to a broader notion of employee “competence” (Boucher et al, 2006). One current trend in many organisations is a divergence concerning the contribution of human capabilities to the success or failure of the organisation. According to Zülch & Becker (2006) the importance of the human resources for the long-term success of the company is obvious, but at the same time these resources are planned rather mechanically, comparable to the planning of machinery resources and material. They claim there is a lack of methods with which individual competencies during planning and decision-making can be taken into account.

Even within the IS community we have followed the literature on systems supporting competence management (see for example Lindgren et al (2004); Håland & Tjora (2006)). They claim that there are few information systems specially designed to help organizations manage competence both at the individual and the organizational level, and that IT is not considered to manage competence *across* individual and organizational levels.

Furthermore, current and future work life is said to consider the employees as more competent, independent and unique members of the organisations. Hence, strategic management development and individual career planning ought to be seen as two sides of the same coin. Moreover, it constitutes a basis for emancipation and empowerment of the individual (Lindgren, 2002).

We recognise this as a call for re-conceptualising the notion of competence, and thereby introducing more innovative and flexible views on what competence could be and how it can be approached in order to be facilitated in IT tools and systems. Previous research, from which we realise that there exist various notions on competence management, mainly rely on the intra-organisational view, i.e. competence notions that exist *inside* the organisation. Realising that human capabilities and core competencies are vital for business value and success, we argue that competence is an infinite resource that challenges the dominant competence views grounded in organisational levels only. Viewing competence as intangible assets, as negotiable goods and deliverables, implies that a *network level* provides a new, unexplored dimension of competence management. However, several problems have to be considered in order to have the individual perspective aligned with the network perspective in such systems. A network perspective challenges the hierarchical structure of the company and loosens up the core competencies of the organisation into units of unexplored capabilities of individual co-workers (see for example Knight & Pye, 2005). Furthermore, IT systems can either augment the current structure of competence management or challenge the re-active thinking of it.

Research question and aim

The research question to be answered in this paper is: *How can a network perspective on competence management systems empower co-workers?* We argue that a network perspective on CMS (nCMS) is one potential enabler for empowering the employee. Our ambition is to strengthen the individual's role and influence in what and how competence information is treated. We will propose ways of aligning the individual perspective with the network perspective of managing competence. Hence, the aim of the paper is *to explore more innovative ways of handling such competence information by IT and to discuss what implications for design such an IT system (nCMS) will have.* The paper is based on the empirical findings from an on-going research project (CoMaNwO), as well as inspired by a literature review concerning the notion of competence and competence systems.

The Research Project

The collaboration research project CoMaNwO (Competence Management in Network Organisations), represents a network of organisations, which is the main unit of analysis. The aim of the project is to investigate and further explore each organisations motivation for developing a learning and competence management infrastructure for their network activities. We have a particular focus on the role of IT as a mediating tool for the establishment of such an infrastructure.

The problem domain for the CoMaNwO project is competence management in network organisations, a research area that fits well with the research group's overall research agenda in Work-Integrated Learning (WIL). This research primarily deals with contexts where the "learner" is employed by an organisation and where learning is an integrated part of everyday work. Previous studies of the role of IT with respect to learning and competence management identifies three, partly interrelated, analytical approaches that will guide the research of the CoMaNwO project: (i) IT as an infrastructure for data, information and knowledge, (ii) IT as a medium for communication and collaboration, and (iii) IT as a tool for competence management processes and organisational change. Each of these analytical approaches highlights and emphasises different aspects of work-integrated learning, and by combining them into a holistic approach the problem domain of this project can be thoroughly explored.

The empirical context – Networking Companies, NWC

Launched in 1996, Networking Companies is the oldest and most established network of business organizations within the four-city region comprised of Trollhättan, Vänersborg, Uddevalla and Lysekil. The network is made up of 40

corporations active in this four-city region, the majority of which are suppliers to the automotive and technology industry. A total of 13,000 employees currently work in our member companies. The member organisations range from SME:s with under 50 employees to the leading industries of the region (Volvo Aero and Saab GM)

Started for the purpose of enhancing the competitive strengths of the members by means of both business and competence development, Networking Companies has evolved into being a discussion partner, sounding board and logical meeting place for both established and start-up technology companies in West Sweden. The group is involved in collaborative projects with regional business development entities and with University West. Over the years, they have created relationships and close contacts between their corporate members and their supportive partner organizations.

The goals of the network are to reach larger and more comprehensive marketing solutions, offer cutting edge competence within traditional as well as newly evolving business sectors, in addition to greater collaboration among corporate members. NWC hold regular meetings to which they invite opinion and corporate leaders of interest to their members for the purpose of creating deeper business relationships and contacts.

The goals of NWC (quoted from network's homepage, www.networkingcompanies.se) are:

- Act as a discussion partner for the technology and automotive industry in the four-city region
- Broaden business contacts and create new business development opportunities
- Showcase the cutting edge competence of our corporate members
- Create the preconditions leading to comprehensive, system based industry solutions

Project organization and data collection methods

The CoMaNwO project is a collaboration projects between the board of directors of NWC and Laboratorium for Interaction Technology (research group in Informatics at University West, UW). The network organisation together with six corporate partners selected for this project constitute a representative selection of both SME:s and large corporations in the region. Each company is oriented towards frontline technological development and consequently identifies competence management as the primary challenge for the future. CoMaNwO is organized as a collaborative research project where six researchers from UW together with six members from the industrial firms constitute the project team. The overall organization of the project has been outlined as an iterative and collaborative circle with four stages in each rotation (fig 1). The project model is partly inspired by canonical action research method (see for example Lindgren et al. 2004).

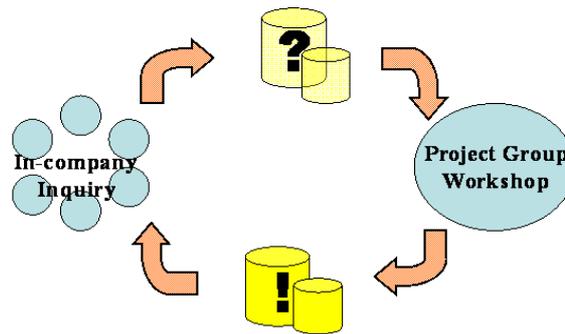


Figure 1. The Project workflow as an iterative collaborative circle.

In the first stage *diagnosing* is conducted through in-company meetings with observations, interviews, surveys and seminars at each participating organization. In the second stage *tentative action planning* is conducted by the research group, this is subsequently discussed and evaluated in a 2-day project group workshop with practitioners, researchers and sometimes external experts. The deliverables from such workshops are *jointly agreed upon action plans*, which are then put into action at the network level. The data collected for this paper is the result of two repetitions of the collaborative circle. More specifically the data consist of:

- Six group interviews with representatives (3-5) from each firm, lasting approximately 1,5 hour.
- Two joint workshops (2 days each) with round-table discussions on themes such as: What is competence? How can it be articulated and supported? What are the design implications for network-CMS
- Web survey that explores respondents' view on competence and competence processes on: (i) individual-, (ii) group-, (iii) company/management-, and (iv) network-level
- Literature studies on designing for competence and workplace learning

Literature Study

The literature study provides an overview of the understandings and usage of competence management and competence management systems in related research, rather than describing established theories for the analysis.

Competence management

Several differentiated notions and views on competencies are current. Boucher et al (2006) use the following levels of competencies: i) individual competence – to deal with the competence of a person; ii) collective competence – to deal with the competence emerging from a group of persons; and iii) global competence – to describe the organisational ability of an enterprise. Much research emphasise the organisational perspective on competencies and focus on issues related to

strategic planning for activities in the organization. For instance, describing competencies from an organizational view is motivated by the concept of core competencies by Prahalad and Hamel (1990). They demand the strategic planning of activities of the organization. The question to be considered for such an organizational view on competency is related to “what does an organization need for future successes?”. The need to measure and control organisational competencies is forced by the fact that organisations have to value their business in terms of both new products and markets, as well as newly acquired competencies.

However, an organisational perspective on competence management is perhaps not only one that needs to be considered. Current trends of outsourcing and coalitions among companies of today require a multi-faceted view on the management of competencies. The sources of human resources are spread across intra-organisational and inter-organisational units. Of course, the concentration on core competencies as internal resources is important for competition, especially if they are unique, hard to imitate and to substitute (Schmiedinger et al, 2005). Furthermore, in their work (Schmiedinger et al, 2005) human competence is defined as network of complex, self-organized professional, methodical, social and personal competencies, created in a life-long biographic development. By having such a view can perhaps be interpreted as accounting more for the individual level of competence management. Therefore human-based organisational competencies are also networks built out of single competence packages of each individual.

According to Lindgren et al (2004) the *usage* of competence management facilitates the specification of an organization’s needs, the identification of competence gaps (between needed and actual competence), competence sourcing, competence development through training and coaching, and the staffing of projects. Such activities and processes are more often supported by various kinds of competence management systems (CMS).

Competence management systems

Systems supporting competence management facilitates competence mappings and clustering as a basis for competence portfolios, which can initiate new business fields or reveal competence gaps, and how to fill these gaps (Lindgren et al, 2004). For such activities, a skill-based (competence described in terms of person descriptions, *based on skills and capabilities*) is appropriate and most often used. However, for the individual competence management, a job-based (competence described in terms of position and job description in organization, *based on task descriptions*) is often used (Lindgren et al, 2004). There is a tension between these two competence views, skill-based competencies (well aligned with the notion of core competence) has a focus on present and future organization, whereas job-based competencies focus on the past (Lindgren et al,

2004). However, according to them (Lindgren et al, 2004) systems supporting competence management relies on a re-active view on competence mainly, where a job-based and instrumental approach is current.

One general problem in CMS is that of correctness and completeness of competence information. It relates to the fact that the information must be trustworthy. It is easy to claim a certain competence, but we need mechanisms to check such evidence. We need independent and transparent verifications for evaluating competencies. The dynamics of competencies, i.e. that there could be increases or losses of competencies over time, should have measurable impacts on a CMS. Also, it has been a challenge to have the competencies comparable. To compare profiles of individual persons, the profile of a person must be compared with a goal profile or with a certain job description. Thus, one must either use the same competence definitions or a translation mechanism between different competencies. To decide that the same definition is used a reference to the definition is given. The backbone of such structures in CMS relies on certain typologies, taxonomies or ontologies (see for example Fotis et al (2003); Lindgren et al (2004); Bennour & Crestani (2006)).

Reviewing some of the current market-leading software packages for competence management provides more functional specific descriptions. Several software packages aim for maximizing workforce skills and competencies in order to monitor organisations' business performance (see for example Krämer et al (2005) and Oracle Peoplesoft Enterprise (2006)). Such systems accounts heavily for the managerial needs of decision information. The systems are well-integrated with other enterprise information systems and they seem to be very data-rich, which in turn requires an effort in having the system up to date. More often, it is a system dedicated only for the managers, but as an "all-purpose" tool for them (Wöls et al, 2003). Such a tool encompasses applications that ensure employee competencies to be in line with the future needs of the organisation. They start with looking at future developments of the market and the needs of their customers and from these goes on to define the core competencies of the unit. This analysis in turn helps to determine the objectives for the management of the employees' competencies and gives good account of how to connect definitions of individual skills with a company's objectives and core competencies. One problem of this kind relates to that the responsibility of and rights to competence information are limited to the hands of HR managers or middle-managers, and are not widely used and re-produced by the individual co-worker. Consequently, our concern about the individual perspective still lacks. Organisational needs and individual's competence interests cannot be treated independently in a CMS, and organizational core competence needs to be aligned with individual level competence and interests, as well as the network level of interests.

Empirical Study

We here will present the preliminary findings from our empirical study. Many fruitful discussions in workshop and interviews reveal a mature and advanced view on competence as a complex phenomenon that need a lot of attention paid in order to be explicitly discussed and facilitated across the networking companies. They were highly engaged in the discussions and extremely motivated to have the issue on their agenda now. A clear ambition was to have the activities, tools and methods for competence management once explored and developed to have the right kind of engagement and quality for both their own organisation's businesses as well as the networking companies' goals and interests. However, the first analysis round was focused on the following themes: status on competence management, network-related competence activities, and individual-related accounts.

Status on competence management

Awareness of the importance of competence managements is high in all companies, but the level of systemizing varies. They want to work with CM as a continuous process with more efficient tools and systems well integrated with daily activities, be more strategic and long sighted and better integrate the individual, group and organizational level of CM. They express the need to get "snapshots" of the competence status, to have more explicit competence profiles, to communicate and get competence profiles accepted, and to make employees enthusiastic to engage in competence development. The extent of work required to produce complete competence information in most CMS is considered a barrier to start a more systematic management. Most companies have competence profiles and positions descriptions documented in business software or elsewhere, but need support for competence management.

Network-related competence activities

Activities related a network perspective were of very big interest. In our empirical findings we have identified a lot of network-enabled businesses that expands the boundaries for competence management. Small businesses actively and deliberately enlarge their business networks, entering into partnerships that help make them purposefully provide value for their businesses. At the same time there were also social networks of *individuals*, individuals who want to share their professional or non-professional interests in communities of various kinds, all providing value for themselves in a more self-directed or personally involved competence development.

Among those activities that were highly ranked but not so widely developed were: commonly organised educations for competence development, competence brokering, project collaboration and partnership constellations. One particular big interest was expressed for building network alliances for common entrepreneurial offerings. Expressions about having a common pool of resources, both personnel and machines, to share during peak- and off-seasons were identified. This comes from that there were changes in the business relationships inside the companies as for instance business units, service groups, or even individual consultants may bid for projects and compete directly with outside suppliers to provide services to their own company.

Individual-related accounts

There were several implications for giving the individual's competence perspective more account. In particular, there was a clear expression about having a more pro-active way of approaching competence management issues. Future plans and interests were the main information needed in such an individual competence profile. There was a clear indication that personal goals and desires also would be included. To have the possibilities of comparing an individual's actual competence with a future or desired one was ranked very high. One other significant result was that many answers pointed out that not only the competence needed for the actual job description should be available, but also competencies that lay a little bit aside from the actual. This implies that there was a wish to have new personal abilities identified, in order to meet necessary competence change.

Furthermore, it was obvious that the individual impact on competence information was to a very little extent considered in current competence management systems within the actual companies. Most strikingly was that many answers indicated "not-knowing" about individual competence information. From a co-worker perspective the individuals did not know what and how their competence information was used. The results also pointed out that the personal integrity must be considered, though information such as personal judgements is subjective and ambiguous it is important to have it explicitly discussed and formulated on a person-to-person basis. What exactly to be represented in competence information should be decided by the person in question. There were many suggestions of how to actually work with, or rather, prepare the individual competence information. Many forms of collaborations or relaxed discussions were proposed. Also, as someone put "a coach/mentor or someone else...", which indicated a non chief-related person.

Implications for Design

To explore design visions and implications for a nCMS we learned that the individual perspective was crucial. Various notions of empowerment were raised during the analysis and several critical questions needed to be posed. What fundamental understandings underlay the concept of competence, as such? How could competencies be represented in a system supporting this view? How can all the competence information be kept current? Who has the responsibility of the information to be kept? Who should be allowed to view the skill profiles of an employee? How can acceptance and trust be built up for such a system? Striving for identifying certain aspects of empowerment we identified and discussed the following design implications:

Pro-activity: Based on our findings, we found that the main interest of both management and individuals' lies in the future. Organizational perspectives include preparation for future challenges and utilizing human resources in accordance with individuals' capacities, ambitions and interests. Individual's interests include personal career options and being up-to-date with professional development to stay attractive at the job market. Hence, strategic management development and individual career planning are not contradictory, but complementary to each other. Furthermore, it constitutes a basis for empowerment of the individual (Lindgren, 2002).

Responsibility: In our project we recognized competence as something extremely complex, encompassing exploited and latent elements, where qualifications of individual workers are not enough representations of individual capabilities. From the empirical study we identified that competence has a broader sense by more degrees of freedom on the one hand, and of responsibility on the other. Individual competence is subject to a continual, situation-related process of evolution. This certain degree of responsibility needs to be managed in an on-going evaluation and assessment process, pre-dominantly conducted by the employees, and thus provide more account for the individual co-worker.

Explicit profile: The "justice" of having the "right" competence information was shown in the study. Competence information needs to be explicitly represented, i.e. defined, explained or formulated. The main idea is to unfold the ambiguity and misinterpretations of information that individuals actually want to define as their competence profile. Such an approach does not necessarily need to have the competence information explicitly codified, but articulated enough into concepts and objects that can then be systematized into a competence management system and used for further exploration and negotiation.

Negotiations: Our position is in alignment with Höfferer & Hiermann (2003), which is that competence of an employee can never be fully reproduced in a system. Perhaps, the exact "right" kind of information cannot be accomplished. Some types of competencies are maybe less problematic (e.g., formal

qualifications, documented experience etc) since these can be seen as objective facts, whereas other (e.g., abilities, behaviour, transferability of knowledge and know-how in new situations) are subjective to *judgement and opinion*. The latter are of necessity estimations, and are subjective to negotiation. By also having a focus on the future, competence estimations in relevant areas is the most useful information. However, since estimations are difficult to value, these need to be accompanied with “arguments”, which are the underlying reason for the estimation.

Integrity: The personal integrity of data represented in a competence management system was frequently discussed. The data stored about human competencies is very sensible. The profile of a person is private, but sometimes the person will be interested that knowledge is passed over to others (e.g., if the person is looking for a new job, or could contribute in a certain role of the network, e.g. a mentor). Usually it will be no problem if available skills of a candidate are passed to an organization. If, however, evaluations of skills or the lack of skills is passed, this may be seen negatively by the human resource. Sometimes it will be also not desired to pass information about certain “positive” skills because the candidate does not want to have a job where these skills are required. The image a candidate wants to give to other parties will be governed by personal goals such as expectations which skills will be learned in a new job. Thus, each person whose skills are stored must have full control about which data is given to other parties.

Discussion

What role might such a nCMS have for empowering the individuals? More employee-controlled and -managed competence management system might lead to have the individuals feel more empowered. When individuals are engaged in their competence information, they might be far more likely to participate and contribute, and thus the information could be developed incrementally. Everyone has the responsibility for maintaining the personal integrity and to build the climate of empowerment. Individual co-workers can express interests and future ambitions so management can take this into consideration in their decisions. Another implication that was discussed concerned that the individuals might be more aware of their role in the organization, and how their own competencies fit into the big picture. At the same time they could be more aware of company strategic directions, and be more in control of their opportunities and potential threats in advance.

To focus on network organisations’ collaborating activities (e.g. knowledge brokering, peer-to-peer professional meetings, inter-organisational competence development, mentoring etc), requires loosening the organisational control of the individual competence. The view on competence of one individual employee has

to be extended to include areas such as interests and competences that might lay aside the more organisational-related competence. Consequently, the competence market will be opened up, for both individuals and organisations. This will have mutual effects. From a network perspective, an extended set of individual interest and competence repository would enable other organisations to identify and utilize complementary competence. Employees who have led different type of projects can usually be helpful to others if they share their experiences through coaching or mentoring session for instance. From an individual perspective, employees might see empowerment as an opportunity to market their competence in the organisational network, motivated either by their own competence interest or network competence needs and interests. So, the individuals will be more empowered trailed by flexible networking role commitment, continuous learning, and individual career possibilities as most important features.

Conclusion and Further Work

The research question to be answered in this paper was: *How can a network perspective on competence management systems empower co-workers?* We have presented the preliminary findings from an on-going research project aiming at designing a competence management system for networking organisations. We have realised that the network perspective is an important enabler for empowering employees. To focus on the network perspective on competence management systems requires loosening the organisational control of the individual competence. We have analysed in what way the individual co-worker might be empowered by identifying certain implications for design of a nCMS.

Further work include a deeper analysis of the collected empirical data to iterate the findings related to the design of a nCMS. The design implications need to be further explored and discussed in order to be refined and operationaliseable to a systems development initiative.

References

- Bennour, M., and Crestani, D. (2006), Using competencies in performance estimation: From the activity to the process, *Computers in Industry*, online at www.sciencedirect.com, Elsevier, 2006.
- Boucher, X., Bonjour, E., and Grabot, B. (2006), Formalisation and user of competencies for industrial performance optimisation: A Survey, *Computers in Industry*, online at www.sciencedirect.com, Elsevier, 2006.
- Fotis, D., Chamopoulou, P., and Mentzas, G. (2003), An Ontology Based Tool for Competency Management and Learning Paths.

- Harzallah M., Berio G., Vernadat F. (2002), A formal model for assessing individual competence in enterprises, in Proceedings of the IEEE Conf. Systems, Man and Cybernetics, Tunisia, 2002
- Håland, E., and Tjora, A. (2006), Between asset and process: developing competence by implementing a learning management system, In Journal of Human Relations, 59 (7), pp 993-1016, Sage Publications, London, UK.
- Höfferer, M and Hiermann, W. (2003), BEKO-SMS: a practical Knowledge-based Approach to Skill Management. In Proceedings of I-Know 03 - Third International Conference on Knowledge Management, Graz Austria, 2003.
- Knight, L., and Pye, A. (2005), Network learning: An empirically derived model of learning by groups of organisations, In Journal of Human Relations, 58 (3), pp 369-392, Sage Publications, London, UK.
- Krämer, Ch., S. Ringling, and Yang, S. (2005), Mastering HR Management with SAP. The complete guide to SAP HR, Galileo Press.
- Lindgren, R. 2002. Competence Visualizer: Generating Competence Patterns of Organizational Groups. In *Proceedings of the 35th Annual Hawaii international Conference on System Sciences (Hicss'02)-Volume 4 - Volume 4* (January 07 - 10, 2002). HICSS. IEEE Computer Society, Washington, DC, 108.
- Lindgren, R., O. Henfridsson, and U. Schultze (2004) Design Principles for Competence Management Systems: A Synthesis of an Action Research Study, MIS Quarterly Vol. 28 No. 3, pp. 435-472 September.
- Prahalad, C.K, Hamel, G (1990). The core competences of the corporation, *Harvard Business Review*, pp.79-91.
- Schmiedinger, B., Valentin, K., and Stephan, E. (2005), Competence Based Business Development – Organizational Competencies as Basis for Successful Companies, In Proceedings of I-Know 05 – International Conference on Knowledge Management, Graz Austria, 2005.
- Wöls, K., Kirchpal, S., and Ley, T. (2003), Skills Management – an “all-purpose” Tool? In Proceedings of I-Know 03 – International Conference on Knowledge Management, Graz Austria, 2003.
- Zülch, G. and Becker, M. (2006), Computer-supported competence management: Evolution of industrial processes as life cycles of organizations, Computers in Industry, online at www.sciencedirect.com, Elsevier, 2006.

Physicians' views toward mobile HIS

Katja Leiviskä

University of Oulu, Department of Information Processing Science, Finland

katja.leiviska@oulu.fi

Abstract. This paper presents the physicians' views towards mobile systems. The idea was to conduct a preliminary study with a small number of physicians. The data was collected through interviews. The results suggest that physicians have clear ideas of unwanted and wanted characteristics of mobile services. These wanted characteristics are ease of use, receiving the information quickly, reliability, simplicity, interactions and access to database. The unwanted characteristics of the mobile services are slow service and connection failing, complicated, inequality in the use of services caused by the device and too many reminders. They also have clear thoughts of the needed mobile applications in the clinical settings.

Keywords. Healthcare information system, mobile healthcare information system

1 Introduction

The healthcare sector is an information intensive industry. The use of mobile services varies in the healthcare sector in different countries. In the United States there are many vendors' offering mobile applications for physicians. Still, the use of mobile services in Finland's healthcare industry is still minor. Even so, there is a place for mobile information and communication systems in the healthcare clinical settings (Ammenwerth et al. 2000). Recent research about mobile healthcare information systems have been made from different perspectives such as medical errors (Chen et al. 2004), user acceptance (Han et al. 2006, Liang et al. 2003), use of mobile devices, (Criswell and Parchman 2002) use of mobile systems (Kearney et al. 2006), wireless technologies (Varshney 2006) and knowledge management (Räisänen et al. 2007), but studies from the expectations of the user view is still rare.

This article aims to study the physicians' views toward mobile healthcare information systems (mobile HIS). The data was collected through interviews. The physicians think that certain characteristics of mobile services are needed and some unwanted. They also suggest some ideas for mobile services wanted by the physicians.

This paper is organized as follows. Health care information systems, mobile HIS and studies related to mobile HIS are presented in chapter 2. Research methods and setting are presented in chapter 3. Results: physicians' views toward mobile HIS are discussed in chapter 4. The results are discussed in chapter 5. Conclusions are presented in chapter 6.

2 Literature review

2.1 Healthcare information systems (HIS)

The terms health informatics and medical informatics are usually used synonymously. According Hasman et al. (1996) the terms have different meanings in various countries. For example, in Germany medical informatics includes also nursing informatics and dental informatics. In some other countries medical informatics is primarily focused on solutions for physicians. Health informatics as defined by Hasman et al. (1995) is the "systematic processing of health related data, information and knowledge by computers." Health informatics focus on the study of information-processing principles and offers solutions to information-processing problems in health care (Hasman et al. 1995).

Medical informatics, as defined by Hasman et al. (1996), is the scientific discipline related with the systematic processing of data, information and knowledge in medicine and health care. It can be examined from a number of different perspectives e.g. information technology and user needs. Van Bommel (1997) defines medical informatics as comprising of "the theoretical and practical aspects of information processing and communication, based on knowledge and experience derived from processes in medicine and health care." Medical informatics as defined by Van der Lei (2002) is the intersection of the terms medicine and informatics: medicine is the area of research and informatics is the methodology used. The medical informatics research aspect and the role of computers varies. Medical informatics develops and assesses methods and systems for processing, acquisition and interpretation of patient data (Van der Lei 2002.)

Siau (2003) classifies a basic set of tools that can be applied to health care industry. These are Internet applications, Enterprise systems and Mobile Health

Care Systems. The healthcare industry uses three primary Internet applications such as Internet, intranets and extranets. Enterprise systems are enterprise resource planning systems (ERP) customer relationship management (CRM), clinical decision support systems (CDSS), data mining and data warehousing programs.

Another way to categorize health care information systems is defined by Suomi (2001). This view includes classes of customer supporting systems, interaction supporting systems, consultation systems, decision supporting systems, process supporting systems, economical systems, preparation tools and administrative tools. The idea of this classification is in the interaction between the medical personnel and the patient. According to Raghupathi (1997) the applications of IT in health care are named as "health care information systems"(HCIS). HCIS encompass a wide range of applications from many disciplines including e.g. medicine, computer science, management science and statistics.

Chiasson and Davidson have (2004) referred to Health information systems research (HISR) that is the term for the multidisciplinary body of knowledge related to the e.g. design, development, implementation and use of information-intensive technologies in healthcare. According to them, healthcare provides opportunities to develop and refine IS theory.

2.2 Classification of Mobile Healthcare Information Systems (mobile HIS)

Mobile computing can be seen in many ways. According to Davis (2002) mobile, ubiquitous and pervasive computing are often treated as synonymous. Lyytinen and Yoo (2002) see mobile computing as "fundamentally about increasing your capacity to physically move computing services with us. As a result, the computer becomes a taken-for-granted, ever-present device that expands our capabilities to inscribe, remember, communicate, and reason independently of the device's location." Martins & Jones (2004) refers to mobile information communication technology (MICT) and it means that "computers potentially occupy any given space wherever people decide to take them". There are also many kinds of devices that may be used as mobile healthcare information systems such as PDAs, laptops, cell phones, medical trolleys and tablets (Ooi et al. 2005).

Lu et al. (2005) classifies applications of personal digital assistants into decision support, administrative support, documentation and professional activities (e.g. electronic prescribing, education and research). Decision support

applications include access to information related to patient, medical reference and diagnostic data management. Administrative support applications are related to e.g. billing and scheduling. (Lu et al 2005.) There are also new kinds of PDA applications, e.g. vital signs management systems where the system's idea is to support data acquisition of vital signs in remote locations by using the mobile device (Cruz & Barros 2005). PDAs have been used in medical student and junior physician education, and they have also been used in daily clinical practice for drug reference and treatment safety, patient scheduling and tracking, improving quality of care, decision support, to educate and interact with patients, as well as for data collection (Baumgart 2005).

According to Baumgart (2005) medical software may be grouped as standard medical textbooks and manuals (PDA), medical references for PDA, drug reference and interaction check programs, medical prediction rule applets, medical calculators, image viewers, prescribing and pharmacy-dispensing systems and educational programs, medical alerting messaging, and comprehensive medical enterprise solutions integrating with electronic medical records, document readers, subscription platforms to electronic newsletters, medical prediction rule applets and software to medical evidence retrieval. Fischer et al. (2003) have reported about handheld devices in medicine and they suggest that the main use is to access medical literature, electronic pharmacopoeias, patient tracking, medical education, research, e-prescribing, business management, and specialty-specific applications. Access to medical literature includes information about medical handbooks and textbooks. Pharmacopoeias are drug information databases. Handheld devices can be used to monitor patients' health and there are many customized patient-tracking programs. Handheld devices are used in medical education for evaluation of student training. Research uses handheld computers for data collection. PDAs can be used to improve business efficiency by improving coordination of physicians' schedules and communication. Prescribing can be done by using handheld devices. Specialty-specific applications, e.g. in family practice, can deliver access to evidence-based information. (Fischer 2003.) Adatia & Bedard (2003) use similar categories for physicians' handheld software: general medical reference programs, downloadable journal content, pharmacopoeias, medical calculators, patient-tracking programs, billing and coding software, handheld word processing and office programs. Embi (2001) defines current medical applications by use of the handhelds: access medical reference information, make medical calculations, code and bill for patient encounters, write prescriptions and track patient data.

2.3 Mobile HIS studies

There are many studies on medical errors. According to Chen et al. (2004) many of these studies have shown that inadequate access to patient information and ineffective communication between healthcare team members are causes of medical errors. Also in Grasso's and Genest (2001) study about PDAs in the Department of Pharmacy have been shown that better access to patient and drug information by medical staff decreases medication error rates. The quantitative survey of Rothschild et al. (2002) was conducted as a seven-day online survey of 3000 randomly selected ePocrates Rx (Palmtop drug information guide) users. The survey response rate was 32 percent (n=946). The results suggest that ePocrates RX saves time during information retrieval, improves drug related decision making and is easy incorporated into their workflow. According to Rotschild et al. (2002) drug information databases that are on handheld devices improve drug knowledge and may decrease medication errors.

The quantitative Internet survey of Räsänen et al. (2007) was done during two-week period for the 352 physicians of Duodecim's mobile software users. Response rate was 66.5 percent (n=234). The results suggest that the mobile system may improve organizational knowledge creation and the knowledge work of physicians in their jobs. It may also support and enhance the performance of the whole working community.

There are, relatively, many studies related to user acceptance. Han et al. (2006) surveyed the technology acceptance of 151 physicians in Finland, suggesting an explanatory model for explaining physicians' intentions to use the system. There are important determinants of their behavioral intentions in the early exposure to mobile systems. Those determinants were perceived as usefulness, the interaction effects of Personal Innovativeness in the domain of Information Technology (PIIT) and age on ease of use and of age on compatibility. The physicians had rather positive attitudes for using mobile communication technology in their daily work. Similarly, Liang et al. (2003) are suggesting that their extended Technology Acceptance Model may be used to predict actual mobile usage. Han et al. (2004a) explore physicians' willingness to accept mobile medical information systems, focusing on the effects of temporal and spatial working behavior. Fragmentation of working space is a measure of spatial working behavior. Fragmentation of working time is a measure of temporal working behavior (Han et al. 2004a).

There are studies related to the use of handheld devices and systems. According to Criswell and Parchman (2002), handheld computers are in wide use in family practice residency programs within the United States. Kearney et al. (2006) have shown that the use of handheld symptom management tool is

acceptable and feasible to cancer patients and health professionals. According to Lapinsky et al. (2004) an updateable handheld computer system is feasible by providing access to medical reference material. This system may improve clinical decision making (Lapinsky et al. 2004). The study of medical students use of handheld computers uploaded with clinical decision support software (CDSS) suggest that CDSS may be able to provide students with better access to high quality information (Johnston et al. 2004). Johnston et al. (2004) also suggest that handheld computers with CDSS may do the adoption of evidence-based medicine easier (EBM) among medical students. The study of Sintchenko et al. (2005) also suggests that use of handheld computer-based decision support system can reduce the patient length of stay in hospital and antibiotic prescribing in a critical care unit. Han et al. (2004b; 2005) have shown that physicians' have rather positive perceptions of the mobile medical information system and have intentions to use it. Lu, Lee et al. (2003) suggests that there are four types of barriers to PDA usage: organizational, usability, inadequate technology support or access barriers and lack of need or motivation. Fischer et al. (2003) report that only a small number of articles provide evidence-based information about the use of PDAs in medicine. Recent research about mobile HIS have been made from different perspectives but studies from the expectations of the users is still rare. To fill this gap, we have studied the physicians' views toward the mobile HIS.

3 Research methods and setting

3.1 Research question

The aim of this study is to study physicians' views toward mobile HIS. The research question of this study is: What kind of views physicians' have toward mobile HIS? There is one sub question: What kind mobile services physicians' would like to have?

3.2 Data collection and analysis

The idea was conduct a preliminary study with a small number of physicians. The data was collected through interviews in autumn 2006. Semi-structured interview was conducted as an interview method. All interviews were recorded and transcriptions were produced.

The research population consisted of three physicians who were working in the same health center. Their backgrounds were different. Two of them had a long working history as a physician. One of them had working experience of only two years. Only one of the doctors had little experience about the use of mobile HIS.

The other two doctors did not have any experience about the use of mobile HIS. All of them had some experience of different mobile services, but no professional experience of them. Qualitative content analysis was employed as the research method for this study. Content analysis is useful in abstracting the key information. So a good content analysis aims to compact the important information and put the key message of the original material in a brief and concise form (Strauss & Corbin 1990, 22.). Original quotes from the text are included to support our findings and categorizations. The categories synthesized from the text express the respondents' true opinions about mobile HIS. Physicians' views were about mobile healthcare information systems general and especially their expectations about mobile services.

4 Results: physicians' views toward mobile HIS

The results suggest both positive and negative views toward the mobile HIS. These two main classes are positive characteristics and negative characteristics (Table 1). These characteristics are the wanted and unwanted characteristics that are wanted in a mobile service.

positive characteristics	negative characteristics
reliability	slow
receiving information quickly	complicated
ease of use, simplicity	inequality in the use of services caused by the device
interactions	problems with the connection
access to database	too many reminders

Table 1. The results of the study.

4.1 Positive characteristics

The physicians think that certain characteristics of mobile services are needed such as ease of use, receiving the information quickly and simplicity. These characteristics are wanted ones in the mobile services.

“ But simplicity and unnecessary things away are asset”

“ ..that usually maybe that they are ease of use so that the information can be received quickly and you don't need in an way use connection a long time.”

“ ..mobility I believe so that it supports if it is ease of use..”

Also two physicians think that reliability of information is a very important characteristic of the mobile services.

“ Usually you give up that kind of service if you don't know can you use it or not. It has to be hundred percent reliability.”

“.. the reliability of information, usability so that it in a way supports the decision- making in the one patient meeting, it is the work of the basic physician.”

One physician mentioned that interactions are wanted characteristics. According to her, it is nice to get some kind of warnings if you may do some kind of faults.

“ And always interaction databases are nice to be..”

According to one doctor, the wanted characteristics are access to the database and getting the information that is needed.

“ That mainly it is so that there has been right database chosen for that purpose.”

4.2 Negative characteristics

Negative characteristics are unwanted matters in the mobile services. Two doctors consider that the problem areas in the mobile services are slow service and connection failing.

“ But I don't know what characteristic can be unwanted, of course such as slow or the connection is not working.”

“So that the mobile device is not computer, connection is slow, connection is breaking down, this is only my experience.”

Still the interaction possibilities are mentioned as a positive characteristic but one of the physicians' also mentioned that a large amount of 'reminder messages' can also be problematic. She thinks that you can become torpid if there is too much reminders.

“ ..if reminders are send to phone about every matter, so you can become torpid toward them.”

Complexity of the mobile service is seen to be a negative characteristic.

“ Bad mobile service is too complex , too much everything, is slow and breaks down and it frustrates, because in the theory this service could be existing but you cannot ever get it operate.”

One of the physicians' think that mobile phones might set the users in unequal status.

“If you think that you get an information or you get a message and picture on the phone so it depends of what kind of phone you are using and how you are getting it and what size is your display and so on. Mainly I am thinking is that a problem, or does it treat people with unequal status depending on the devices they have.”

4.3 Physicians' ideas and views toward mobile services

Physicians have also some ideas of what kind of mobile services that could be made. These services are addressed mainly to cell phone. Their presentations are based on their opinions about what kind of services would be useful in their work. The ideas are shown in table 2. Electronic pharmaca fennica is a drug information database. Mobile permission procedure relates to discussion of permissions to look at patients' drug information from the database. Special compensable drugs are drugs that will be compensated by The Social Insurance Institution of Finland (Kela). When physician has given a medical certificate of a disease and the patient has delivered this certificate to Kela, then the patient is allowed to get compensation for that drug in the pharmacy. These medical certificates are permanent or fixed-period. The fixed-period certificates have to be renewed by the physician. A reminder for special compensable drugs is needed to remind physician to renew the certificates that are still needed. The work support application is an application that would bring information about the diseases and drug information. Medical information would be linked to pictures and this software could be used with a mobile device. A mobile connection to an appointment application is a mobile application that would allow the physician to look at her/his appointments for the next day. A monitoring application would be an application that would monitor patient's condition. This would be a light version of an intensive care unit's monitoring systems and it would be used in the emergency unit or in the operating theatre.

Electronic pharmaca fennica
Mobile permission procedure
Reminder for special compensable drugs
Work support application
Mobile connection to appointment application
Monitoring application

Table 2. The ideas of the study.

The physicians were also asked if they would use a mobile service related to medication knowledge. According to the two respondents, they are willing to use the mobile services that are related to medication knowledge.

“ I would use it, because all the information is nice. There is too much information so that you cannot store all of it in your head.”

“ Yes I certainly would use it..”

One of the physicians wanted electronic pharmaca fennica to take it with her in the home calls.

“ Mainly that, it may be already exist, so that you could get the electronic pharmaca with you in the house calls..”

One physician thinks that it would be good to have a mobile permission procedure to check all of the patient's drug information from the database. The doctor could ask from the patient the permission to check patient's drug information and then the physician could put some kind of a sign to the mobile service. After that the patient's drug information can be read from the database. This mobile permission procedure could be done also by patient. The present permission protocol is seen as been hard.

“ ..patient could check it and then there is already the permission to check, if he put it from his mobile phone, so it would be of course easy.”

“Or other could be that we could have the permission, the patient marks it or we could put some kind of mark ourselves, so that we have received verbal permission and we could look the drug information from the database, it would be easy.”

One physician suggests that it would be nice to have a mobile service which could support their work.

“..in the mobile side it would not be verbal but on the contrary meaningful information and it would be related to occupational matters and it would be linked to those essential information.”

One physician thinks that it would be nice to have a reminder for special compensable drugs. This means that the reminder would be sent to doctor when it is time to renew a special compensable drug for some patients.

“ .. so if some human has compensable for example blood pressure drugs, asthma drugs and it is allowed for certain time, so when it will expire the reminder could be send...”

Also one of the physicians' mentioned that she would like to have a mobile connection to the appointment application that is in use in her working place. The

other physician had an idea for monitoring application that could be used in the emergency room or in the operation theatre.

“ I sometimes would like to look my book of appointments..”

“..these kind of monitoring labels and mobile works so all it takes that there is one centralized unit, where is same kind of monitoring like it is in intensive care unit but with little light loading.”

5 Discussion

As the results show physicians have listed both positive and negative characteristics of the mobile HIS. Physicians have a crisp answer to certain characteristics which are needed to be in a mobile service. These characteristics are ease of use, receiving the information quickly, reliability, simplicity, interactions and access to database. Physicians consider that the negative characteristics in the mobile services are slow service and connection failing, complicated, inequality in the use of services caused by the device, too many reminders. Some of those negative characteristics are mentioned also in other studies such as too many reminders (Lu, Lee et al. 2003). Physicians have ideas about what kind of mobile services they could use. These mobile services were electronic pharmaca fennica, mobile permission procedure, reminder for special compensable drugs, work support application, a mobile connection to appointment application and monitoring application. Electronic pharmaca fennica is a drug information database. Mobile permission procedure is a means in which permissions can be received by using the mobile services. A reminder for special compensable drugs would be an application to remind the physician to renew the certificates. The work support application would be an application that would provide information about the diseases and drug information. A mobile connection to an appointment application would be a mobile application that would allow the physician to look at her/his appointments for the next day. A monitoring application would be an application that would monitor a patient's condition. All these proposed applications are different from each other and might bring some new ideas to work with in the future. Even though some of the ideas are already available as applications, these ideas can give opportunities to think about what kinds of mobile services are wanted by physicians. As is known, the reasons for failures in information systems development varies e.g information system use problems (Nykänen and Karimaa 2006). It is also known, that if user is a non-champion in the use of information system (IS), he/she may have less positive views toward IS and may use the IS less (Miller and Sim 2004). From this point of view it may be an important aspect to consider that expectations may impact to actual use of mobile services such as vice versa.

6 Conclusions

This study can help to understand what kind of views physicians have toward mobile HIS. Physicians have clear views toward mobile HIS. They can point out what kinds of characteristics are needed and what are unwanted. Also, the need for different mobile services from physicians view is clearly pointed out.

There are some limitations such a sample size and respondents background. The number of respondents' was small, but this study aim was to conduct a preliminary study with a small number of physicians. The respondents amount was three and so any generalization of study results cannot be made. Also, the background of the use of the mobile devices by respondents varies and the working experience was different between the physicians. This study is indicative and it is meant to be renewed with more respondents with different working backgrounds. The respondents should also have tried mobile HIS professionally. The future research will be directed to the same kind of qualitative research with a larger sample size. Also other factors may be taken into account, such as user experience and relevant theory background.

References

- Adatia, F. and Bedard, P. (2003). "Palm reading : 2. Hanheld software for physicians". *Canadian Medical Association Journal* , vol. 168, no.6, 727-734.
- Ammenwerth,E., Buchauer, A., Bludau, B. and Haux, R. (2000). "Mobile information and communication tools in the hospital", *International Journal of Medical Informatics*, vol. 57, no.1, 21-40.
- Baumgart, D. (2005). "Personal digital assistants in health care: experienced clinicians in the palm of your hand? ", *The Lancet*, vol 366, 1210-1222.
- Chen, E., Eneida, M., McKnight, L., Stetson, P., Lei, J. and Cimino, J. (2004). "PalmCIS: A Wireless Handheld Aplication for Satisfying Clinician Information Needs", *Journal of the American Medical Informatics Association*, vol. 11, no.1, 19-28.
- Chiasson, M. and Davidson, E. (2004). "Pushing the contextual envelope: developing and diffusing IS theory for health information systems research", *Information and Organization* vol. 14, 155-188.
- Criswell, D. & Parchman (2002). "Handheld Computer Use in U.S. Family Practice Residency Programs", *Journal of the American Medical Informatics Association*, vol. 9, 80-86.
- Cruz, D. and Barros, E. (2005). "Vital signs remote management system for PDAs", *Proceedings of the 2005 8th Euromicro conference on Digital System Design*. IEEE 2005.
- Davis GB. (2002) "Anytime/Anyplace Computing and the Future of Knowledge Work", *Communication of the ACM* ,vol. 45, no.12, 67-73.
- Embi, P. (2001). "Information at hand: Using handheld computers in medicine", *Cleveland clinic journal of medicine*. Vo. 68, No.10, 840-853.
- Fischer, S., Mehta, S., and Lapinsky, S.E. (2003) "Handheld computing in medicine",

- Journal of the American Medical Informatics Association*, Vol.10, No.2, 139-149.
- Grasso BC and Genest R (2001). "Clinical computer: Use of a personal digital assistant in reducing medication error rates", *Psychiatric Services*; vol. 52, no.7, 883–884.
- Han, S., Mustonen, P., Seppänen, M. and Kallio, M. (2006). "Physician's acceptance of mobile communication technology: an exploratory study", *International Journal of Mobile Communications*, vol. 4, No. 2, 210-230.
- Han, S., Mustonen, P., Seppänen, M. and Kallio, M. (2004a). "Physicians' behaviour intentions regarding the use of mobile technology: an exploratory study", *Proceedings of the 8 th Pacific Asia Conference on Information Systems (PACIS)*, Sanghai, China, 8-11 July, 2004.
- Han S., Harkke V., Mustonen P., Seppänen M. and Kallio M. (2004b) "Mobilizing medical information and knowledge: some insights from a survey", *In Proceedings of the 12th European Conference on Information Systems (ECIS)*, Turku, Finland.
- Han S., Harkke V., Mustonen P., Seppänen M. and Kallio M. (2005). "Understanding physician acceptance of mobile technology: insights from two telephone interviews in Finland", *International Journal of Electronic Healthcare*, vol. 1, no.4, 380-395.
- Hasman, A., Albert, A. Wianwright, P. Klar, R and Sosa, M. (1995). *Education and training in health informatics in Europe*. State of art, guidelines, applications. IOS Press, Amsterdam, Technology and Informatics 25.
- Hasman, A., Haux, R. and Albert, A. (1996). "A systematic view on medical informatics", *Computer methods and Programs in Biomedicine*, vol.51, 131-139.
- Johnston, J., Leung, G., Tin, K., Lai-Ming H., Lam, W. and Fielding, R. (2004). "Evaluation of a handheld clinical decision support tool for evidence-based learning and practice in medical undergraduates", *Medical Education*, vol. 38, Issue 6, 628-637.
- Kearney, N., Kidd, L., Miller, M., Sage, M., Khorrami, J., McGee, M., Niven, K. and Gray, P. (2006). "Utilising handheld computers to monitor and support patients receiving chemotherapy: result of a UK-based feasibility study." *Support Care Cancer* 14, 742-752.
- Lapinsky, S., Wax, R., Showalter, R., Martinez-Motta, C. Hallett, D., Mehta, S., Burry, L. and Stewart, T. (2004). "Prospective evaluation of a n internet-linked handheld computer critical care knowledge access system", *Critical Care*, vol. 8, no. 6, 414-421.
- Liang, H., Xue, Y. and Byrd, T. (2003). "PDA usage in healthcare professionals: testing an extended technology acceptance model", *International Journal of Mobile Communications*, vol. 1, no. 4, 372-389.
- Lu, Y., Xiao, Y., Sears, A. and Jacko, J. (2005). "A review and a framework of handheld computer adoption in healthcare", *International Journal of Medical Informatics*, vol. 74, 409-422.
- Lu, Y., Lee, J., Xiao, Y., Sears, A., Jacko, J. and Charters K. (2003). "Why don't Physicians Use Their Personal Digital Assistants?", *AMIA 2003 Symposium Proceedings* 405-409.
- Lyytinen, K. and Yoo, Y. (2002). "Issues and Challenges in Ubiquitous Computing", *Communication of the ACM*, vol. 45, no.12, 63-65.
- Martins, HMG. and Jones, MR. (2004). "Implementing mobile computing to support service delivery at the point of care: review of issues involved", *Healthcare Computing*, 196-202.
- Miller, R. and Sim, I. (2004). "Physicians' Use Of Electronic Medical Records: Barriers And Solutions", *Health Affairs*, vol.23, Iss. 2, 116.
- Nykänen, P. and Karimaa, E. (2006). "Success and Failure Factors in the Regional Health Information System Design Process." *Methods inf Med*, 45.
- Ooi, P., Culjak, G. and Lawrence, E. (2005) "*Wireless and Wearable Overview: Stages of Growth Theory in Medical Technology Applications*", *Proceedings of the International Conference on Mobile Business (ICMB'05)*.

- Raghupathi, W. (1997). "Health Care Information Systems. ", *Communications of the ACM*, vol. 40, no. 8, 81-82.
- Rothschild JM, Lee TH, Bae T and Bates DW (2002). "Clinician use of a palmtop drug reference guide", *Journal of the American Medical Informatics Association*, vol. 9, no. 3, 223–229.
- Räisänen T., Oinas-Kukkonen H., Leiviskä K., Kallio M. and Seppänen M. (2007). "A Case Study on Managing Mobile Healthcare Knowledge." Submitted.
- Siau, K. (2003). "Health Care Informatics", *IEEE Transactions on Information Technology in Biomedicine*, vol. 7, no.1, 1-6.
- Sintchenko, V., Iredell, J. Gilbert, G. and Coiera, E. (2005). "Handheld Computer-based Decision Support Reduces Patient Length of Stay and Antibiotic Prescribing in Critical Care", *Journal of the American Medical Informatics Association*, vol. 12, no.4, 398-402.
- Strauss, A.L. and Corbin, J. (1990). *Basics of qualitative research: Grounded theory, Procedures and techniques*. London. Sage Publications Ltd.
- Suomi, R. (2001). *Streamlining Operations in Health Care with ICT*. In: *Strategies for Healthcare Information Systems*, ed. by T.A. Spil - R.A Stegwee, 31-44. Idea Group Publishing: Hershey, PA.
- van Bommel, J.H. and Musen, M.A. (1997). *Handbook of Medical Informatics*. Springer, Heidelberg, Germany.
- van der Lei, J. (2002). "Information and communication technology in health care: do we need feedback. ", *International Journal of Medical Informatics*, vol. 65, no: 2, 97-119.
- Varshney U. (2006). "Using wireless technologies in healthcare", *International Journal of Mobile Communications*, vol. 4, no. 3, 354-368.

eHealth : Vitalistic and Sapping Systems

Walter F. Uys
University of Cape Town
wuys@telkomsa.net

Abstract.

The implementation of eHealth is being considered as a panacea for improving public health services in remote areas. In South Africa the deployment of eHealth is hampered by the socio-political, organisational and infrastructural challenges found in public health care.

Key to improving the implementation of eHealth lies in examining what makes some systems more “healthy” than others, and whether these characteristics can be used to implement information systems that have the potential for enhancing the lives of its human stakeholders.

The objective of this paper is to provide a theoretical basis or framework to assess the outcome of eHealth systems that could aid in the improvement of health and wellbeing of South Africans.

Five case studies were examined for the processes and practices that contributed to the impact of the implementation. These were categorised according to the dimensions as outlined by Heeks (2002).

It was found that eHealth can be categorized in a continuum between **sapping** and **vitalising** the organisation, the information chain, people and society.

A *sapping* Information System (IS) is input-driven with a focus on technology to improve efficiency and effectiveness. A key principle for a *vitalistic* IS, is an outcome-driven focus on providing an enabling context for public health service delivery.

In conclusion, it is hoped that this research will aid in the expansion of existing eHealth models and frameworks and create an awareness of the value of IS in improving the standard of health and wellbeing of South African citizens.

Keywords. eHealth, Impact, Vitalistic, Sapping, Information Systems, Implementation, Framework.

Introduction

The focus of research and implementation of Health Information Systems (HIS) is frequently centred on the effectiveness, efficiency, strategic alignment or delivery of management information by means of Information and Communication Technology (ICT) or computerised systems (Ammenwerth, Winter, Brigl & Haux, 2004).

In the health sector, even though information systems may display the above attributes, it may still not make a difference in health service delivery or improve the general standard of health of individuals or organisations.

Wang et al. (2005:50) indicate that “*IT evaluation studies should investigate how actual applications of HIS affect efficiency and quality of hospital (and health) care*”.

The most important aim of HIS should be “*to enhance patient empowerment and improve the quality of care*” according to van't Riet, Berg, Hiddema & Sol (2001). This perspective, also maintained by Hedberg (2003), is that Health ICT's should be utilised for monitoring and improving the health of people throughout their life.

Impact of HIS in Sub-Saharan Africa

Assessing the impact of HIS in developed countries is not easy (Anderson & Aydin, 2005; Neville, O'Reilly, MacDonald, Farrell, Keough & Gates, 2003) although some subjective and objective metrics have been developed (Friedman & Wyatt, 2005). In a developing country such as South Africa, these metrics are even more difficult to apply due to systemic and social challenges with frequent failures of implementation.

According to Littlejohns, Wyatt & Garvican (2003) the benefits and impact of HIS should be proved by experience and sound research, and the unique nature of HIS should be considered in supplier contracts from inception

The evidence of long term positive impact or benefit of HIS in public health care in SA is minimal, with the majority of research identifying mainly challenges as evident in (Booman, Sharp, Martin, Manjate, la Grange & Durrheim, 2003; Braa & Hedberg, 2002; Brink, 1998; Bruce, 2002; Byrne, 2004b; Delaney, 2004; Fernandes, 2004; Harris, 2004; Hedberg, 2003; Herbst, Littlejohns, Collinson & Wyatt, 1999; Khotu, 2001; Khumisi, Seopa & Mokgabudi, 2002; Language, 2004; Littlejohns et al., 2003; Mathews, 2003; Mbananga & Sekokotla, 2002; MEDICOM, 2005; PPP in Healthcare: Inkosi Albert Luthuli Central Hospital - SA, 2004; Rotich, Hannan, Smith, Bii, Odero, Vu, Mamlin, Mamlin, Einterz & Tierney, 2003; Scott, Curtis & Twumasi, 2002; Snyman & Snyman, 2003; Tanser, Hosegood, Benzler & Solarsh, 2001; Wang et al., 2005; Williamson, Stoops & Heywood, 2001).

According to Hedberg (2003), most HIS implementations in SA have experienced organisational issues and challenges, cost-overruns, extended implementation times, collapses, under-utilisation, implementation failure, and significant problems.

Littlejohns et al. (2003) corroborate this by stating that the computer industry has benefited largely by portraying its products as essential for efficient and effective health care.

Rationality of HIS Implementation

According to Lerner and Schiffman (2004), health ICTs tend to move towards the hard or rational paradigm. Their theory is that humans focus on this approach, due to a lack of understanding or know-how to create, fix, and maintain life. On the other hand, man does know how to create science and technology which makes it a lot easier to adopt and implement.

Unfortunately, this focus on the rational paradigm, results in computerised environments fraught with socio-political and technological challenges (Braa, 2003). Hedberg (2003:3) believes that “*the development and current state of Health (Management) Information Systems (HIS) in South Africa largely reflect the health sector as a whole*”. Challenges such as the rapid changes in the public sector and the growth in disease impacts on HIS developments “in a complex, dialectic, techno-political process”.

Despite evidence of increasing social, cultural and technological issues and no quick-fix in implementing eHealth in a developing country such as South Africa, the government has embarked on an ambitious long-term programme for HIS. This programme is to implement a national integrated health record solution that may cost South Africa in excess of ten billion rand, with no guarantee of success (Hedberg, 2003).

eHealth¹ does however present a unique opportunity for the government to focus on the use of ICT to address these challenges, enabling a health program or system through information to enhance healthcare service delivery and the health of its recipients and its human environment (What is eHealth?, 2006).

Social Aspect of HIS Implementation

One approach to improving a system is by focusing on solutions that exist, highlighting why they work, and nurturing their development (Cooperrider, Sorensen, Yaeger & Whitney, 2001).

¹ No clear consensus as to a singular meaning of the term eHealth has been achieved by the health industry (Oh, Rizo, Enkin & Jadad, 2005). This article will not attempt another definition, but will use the term in the context of information systems in health care.

In Information Systems it seems important that a broader focus on the overall health of the Information Systems (including the humanistic social, political and financial aspects) is required by IS and health practitioners. This should be inclusive of all the stakeholders in the IS chain (owners, educators, users, developers, and social, organisational and individual beneficiaries).

In order, therefore, to ensure/improve the possibility of implementing healthy information systems, awareness may need to be built on what factors/approaches contribute to a positive impact. This can be aided by developing a framework for assessing the level of health of an information system.

Thesis Context

This paper is done in the context of Informatics Development for Health in Africa (INDEHELA) and will focus primarily on the impact of HIS on individuals, organisations and society. Following is a graphical representation of this theoretical framework.

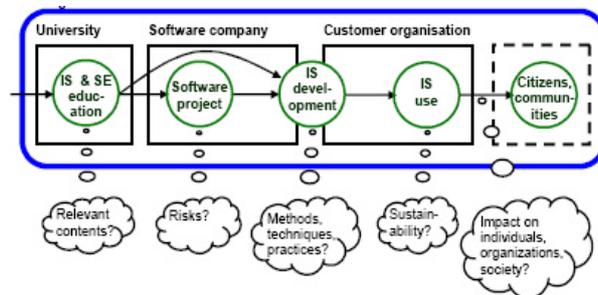


Figure 1 INDEHELA Research context, objects and questions (Korpela, Hanmer, de la Harpe, Macomed, Mursu & Soriyan, 2004:2)

With a plethora of case studies of failed implementations in SA, what is of interest is whether there are health information systems in SA that meet the needs of its' human environment and have a long term positive impact on the individuals' health, the organisation and society.

The research therefore looks at the impact (outcome) of the implementation of HIS, and categorises the practices and processes that have contributed to this outcome.

Philosophical Perspective

When examining a complex social system such as the Public Health system in South Africa, one can look at the system as a living system that behaves unpredictably, is networked, dynamic, not transparent, and unpredictable (Kreyenberg, 2005). This is primarily because it is a system comprised of humans that act unpredictably to events.

Actions or reactions of the system are therefore not linear, as it may behave in a non-deterministic or stochastic way, where only the emergent properties are observable.

This perspective departs from the Newtonian or anthropic mechanism perspective where a rigid set of scientific or mathematic principles can be applied in order to determine actions in space and time (Kreyenberg, 2005:300).

Dennett (1978) identifies three levels of abstraction when predicting the behaviour of complex dynamic systems; namely the physical, design, and intentional stance.

The physical stance is at the level of physics and chemistry such as mass, velocity etc. The design level is concerned with things such as purpose, function and design. The intentional level operates at the level of software and minds, and is concerned with beliefs, desires, thought, and intent (Wikipedia, 2007:Intentional_Stance).

This elevates analyses of a system such as the public health system from mere cause-effect analysis, through looking at design and structure, and ultimately at the desires and intentions of the role-players in the system.

Dennett (1978) does not propose a mechanism for understanding such intent, but does link the intentional stance to evolutionary theory (natural selection) by stating that it is an adaptive advantage to have “the ability to make quick *predictions of a system’s behaviour based on what we think it might be thinking*” (Wikipedia, 2007:Intentional_Stance). It is therefore based more on a phenomenological perspective than scientific method.

The value of this research is that it provides a instrumentalist perspective which can aid in assessing other eHealth implementations. This is relevant to this paper as propositional attitudes (and hence beliefs, desires and intentions) cannot be based on rational scientific process (Dennett, 1978).

Case Studies

This paper examines five case studies selected from the review of HIS implementations in Sub-Saharan Africa namely: the implementation of a Patient Admission System (MEDICOM, 2005); A Health Information System (HIS) in Kwazulu Natal by Scott, Curtis & Twumasi (2002); A Community based HIS in (Berne, 2004); a District Health Information System (DHIS) (Braa & Hedberg, 2002), and a computerised patient record system (Rotich et al., 2003).

Research Methodology

The objective of this research is to evaluate the selected case studies at a design (purpose, function and design) and intentional level (beliefs, desires and intentions).

As with all research, a number of philosophically competing paradigms and/or approaches are evident.

Following an analytical approach, the case studies would be systematically analysed, categorised and reiterated as a comprehensive perspective of existing literature (Jankowicz, 2000; Saunders, Lewis & Thornhill, 2000; Sekaran, 2003). The analytical approach stems from the scientific school; utilising mechanistic positivistic, quantitative, nomethic methods with a focus on objectivity, scientific rigour and replication.

This approach regards the researcher “not as a fellow human being who necessarily interacts with and alters the matter under study, but instead as an abstract reasoning machine” (Crabtree & Miller, 1992:176). The analytical approach excludes the humanistic role of the researcher, both ideographically and as an interpretivist.

The ideographic approach in contrast is “concerned with understanding the particular situation or process being researched in depth” (Mingers, 2001:2), looking at what is unique, stressing differences and examining the context (Chase-Dunn, 1991).

As an interpreter, the role of the researcher is to ‘understand the phenomena through accessing the meanings’ (Baroudi & Orlikowski, 1998:5) based on his beliefs and value system. This approach is often referred to as a hermeneutic approach (Addison, 1992:113; Klein & Myers, 1999) and can be seen as a repeating cycle of iteration between understanding and meaning. This review will be done using the ideographic/hermeneutic approach.

As with health care service delivery approaches of scientific as opposed to natural health, health ICT can be targeted to serve either machine or man (Lerner & Schiffman, 2004). This has parallels in the software engineering or rational (machine), and social or political (man) approaches to Information Systems. The impact of these five eHealth systems, were evaluated according to the two paradigm extremes of ‘hard’ *rational design* and ‘soft’ *political actuality* as outlined in Heeks (2002).

The impact of these case studies is evident to any astute reader. The characteristics however are open to interpretation and the author therefore acknowledges his involvement in the assessment of these items based on his own value judgements and interpretation.

The hypothesis is that if the impact of the system implementation was sapping or vitalistic, then the practices, and approaches used may be a contributing factor. The exception would be where there are some vitalistic aspects in the sapping systems and vice versa. These will however be indicated.

The analyses of the case studies were performed by scanning the case studies for focus areas and practices that matched the dimensions of information technology processes, objectives and values, people, structures, resources from Heeks (2002) and others.

Key aspects of these focus areas/practices were then extracted and grouped according to the objectives and values, approach/processes, issues/challenges/enablers/success factors, impact, beneficiaries, recommendations for research, and the author's interpretation of the case study. In a second iteration, these factors were extracted according to the Heeks dimensions, and subsequently tabulated.

For those not familiar with the case studies, and the process of analysis, it may appear as if the factors seem to emerge out of the blue. This process is however based on the author's experience of Information Systems implementation in the Public Sector in South Africa, and can be seen as an *empirical* exercise for those with the appropriate experience (i.e. "*theory of knowledge emphasizing the role of experience in the formation of ideas*" (Wikipedia, 2007:Empiricism). In the liberal sense it may be seen as an *intuitive* process i.e. "*a form of knowledge where the knower is directly acquainted with the object of knowledge*" (Wikipedia, 2007:Intuition_Knowledge).

Vitalistic eHealth Systems

According to a social constructionism paradigm, man is the creator of technology and as such inscribes his values and beliefs in such technologies. The natural approach realises our limitations as man in the understanding of life (*vitae*), and is based on how to work with life and the human body (and society) and not interfere or manipulate it (Lerner & Schiffman, 2004).

The term vitalism embraces this concept and is defined by the Free Online Dictionary (2007:Vitalism) as "*The theory or doctrine that life processes arise from or contain a nonmaterial vital principle that cannot be explained entirely as physical and chemical phenomena*". Vitalistic practices are therefore practices that pertain, involve or ascribe to vitalism.

Vitalistic Information Systems

A vitalistic Information System is defined as: **A health(y) information system that has a positive impact on its human environment.**

For this paper three case studies of system implementations that exhibit this principle have been selected for analysis. The first one is the implementation of a District Health Information System (DHIS) in South Africa (SA) that "*despite persistent problems with data quality, data flows and utilisation of data/information, has been a major achievement and largely a unifying force across the country*" (Hedberg, 2003:125).

The second case study selected for analysis is the implementation of the Mosoriot Medical Record System (MMRS) in Sub-Saharan Africa (Rotich et al., 2003). In this study, the patient visit duration decreased by more than 75%,

reduced report writing time by more than 15%, and was able to pro-actively identify the outbreak of STD's, and the lack of immunization to which the institution responded.

The third case study is the implementation of a Community based HIS in Kwazulu-Natal (SA) (Berne, 2004) where data collection time was reduced from three hours to one hour, and introduced a paradigm shift of monitoring of communities to the empowerment of communities to monitor themselves and their children.

Sapping Information Systems

The converse of a vitalistic Information System would be: **A system that saps or drains an organisation of its essential lifeblood (resources) in the act of providing information or sustaining it.** This would be an information system where the vendors or implementers derive greater benefit (financial or power) than the organisation or the patients.

The selected case studies for analysis of a sapping system is an example of the failed implementation of the MEDICOM solution in the Pretoria Academic Hospital that is hardly used (MSP, 2004). Revenue for the implementers is generated from licence fees per bed, with the primary aim of financial gain. In an article by Simhan (2002), paradoxically titled "Tapping health from hospital" the company (MEDICOM) claims profitability from day one, with 70% of revenue derived from licence fees. These fees are collected despite the software being used, and whether the proclaimed benefits of the system are obtained.

The second case study selected is the implementation of a Health Information System (HIS) in Kwazulu Natal (SA) by Scott, Curtis & Twumasi (2002) where the institution was left with no capability to support or maintain the information system. The intended benefits of improving health intervention with respect to cancer, and using GIS as a tool to improve accessibility to cancer centres were not achieved. The only apparent beneficiaries of the study were the researchers.

Research Findings

The five Heeks (2002) dimensions (*information technology processes, objectives and values, people, structures, resources*) are the basis of the framework, and the categorisation of the case studies.

Information

Collectively, the case studies are based on health information systems such as patient admission and records (MEDICOM, 2005), epidemiology such as cancer

(Scott et al., 2002), and diseases and treatments (Braa & Hedberg, 2002), health needs of children (love, environment, good growth) by Byrne (2004b).

In the Rotich et al. (2003) and Byrne (2004b) study, paper based information was part of the system. In the MMRS (Rotich et al., 2003), paper format for treatments was maintained (data backups and easier for nurses to use) and a concerted effort made to build trust in the security of the information.

The HISP study (Braa & Hedberg, 2002) achieved 95% data input coverage with the interchange of data and reporting systems acting as the 'institutional glue'. Furthermore, free access is provided to anonymous aggregated health data/information.

According to Braa & Hedberg (2002) standards defined for Public Health Care (PHC) data ensure compatibility and enable comparison across areas. High importance is placed on the feasibility of collecting data (syndromes vs. lab tests) and its usefulness (elements should be expressed as a relevant indicator that is actually used).

Challenges experienced with information flows were that they followed the apartheid legacy of command and control and that data is used as a tool of power and control. This has the unintended consequence of the HIS confirming and reinforcing social contracts and existing power structures (Braa & Hedberg, 2002:120).

Technologies

The technologies varied from traditional server (mainframe) based computing (MEDICOM, 2005) and GIS systems (Scott et al., 2002), to personal computer based database applications such as Microsoft Access (Braa & Hedberg, 2002; Rotich et al., 2003). One case study (Byrne, 2004a) is based on paper data collection and no technologies were used.

The Rotich et al. (2003) study highlighted the adoption of a sustainable power infrastructure suitable to the environment (solar and grid power).

Objectives and Values

Often the authors do not explicitly state the objectives or values used in the case studies. These can however be based on references to goals, aims or implementation plans, which can be inferred. The key objectives and values evident from the case studies were grouped according to sapping and vitalistic impact in Table 1:

Item	Sapping	Vitalistic
<i>Objectives</i>	Selling technology and services (consulting, maintenance and	Creating a "context in which optimal health and well-being are

Item	Sapping	Vitalistic
	training) (MEDICOM, 2005). Evaluation of software. Illustrate spatial aspects of diseases. (Scott et al., 2002). Efficiency & Effectiveness, Design, Implementation (Rotich et al.).	achieved and sustained” (Byrne, 2004b:1). Identifying information needs and supporting district management teams (Braa & Hedberg, 2002). Evolution, Problem Solving and Evaluation (Rotich et al., 2003).
<i>Values</i>	Implementation within time and budget (MEDICOM, 2005).	Care for patients needs (Byrne, 2004b). Catering for others’ needs. Sensitivity to local cultures. Building of trust. Personal time of providers (Rotich et al., 2003).

Table 1 Review of objectives and values in HIS implementation

The overall impact between the two conflicting paradigms is clear and will be included in Table 3 Framework for Vitalistic HIS.

Approach/Processes

Besides the categorisation between hard and soft approaches, four processes are evident; namely focus, participation, involvement and design. Large variances are evident in the approaches used for the defined processes. High level overviews of the approaches are tabulated in Table 2:

Process	Sapping	Vitalistic
<i>Focus</i>	Improvement in efficiency and effectiveness, technology solution, reduced costs (MEDICOM, 2005).	Surveys and evaluations to contribute to the understanding of the context in which the information system was to be designed. Collection and use of data that forms foundation of improving health (Byrne, 2004b:1).
<i>Participation</i>	Consortium of implementation partners. (MEDICOM, 2005). None Amongst researchers (Scott et al., 2002).	Community participation (Byrne, 2004b). Intensive collaboration & negotiations with funders, client, research institutions, developers, countries etc. (Braa & Hedberg, 2002). Collaboration between Educational Institutions (Uni. Indiana & MUCHS) and Host Organisation (Rotich et al., 2003).
<i>Involvement</i>	Worked with selected customer	On-the-job mentoring and coaching

Process	Sapping	Vitalistic
	<p>team to analyse functionality of modules. Formal training of end-users on PC literacy, application functionality and change management just prior to go-live. Hand-holding to ensure (force) usage. Communication with team and partners to deliver 'right message' and keep focus. (MEDICOM, 2005). Request for records and access to files (Scott et al., 2002).</p>	<p>(MEDICOM, 2005). Participatory situational assessment and a monitoring and evaluation workshop. Interviews, focused group discussions, meetings. (Byrne, 2004b). Hosting open day conference & presenting successes. Presentation at national health conference. Training of 75 community health workers and involving them in design process. Development of information culture around CHW. Emphasising importance of IS at community levels within the DHIS (Braa & Hedberg, 2002).</p>
<i>Design</i>	<p>Focus on technical capability and functionality of product; choice of platform & OS; standards based product; reduced hardware footprint; scalable (size). Centralised deployment with remote connection and installation of PCs (MEDICOM, 2005). Automating manual information (Rotich et al., 2003; Scott et al., 2002); changes in design and implementation as early experiences did not bear out assumptions (Rotich et al., 2003).</p>	<p>Understanding of context (powers, traditions and customs, socio-economic conditions). Participatory approach in design. Designing of system to: manage childhood illnesses better and better attain a state of well-being for their children; learn from their, and others' experiences; make informed decisions; and claim their and their children's rights by holding duty bearers accountable. (Byrne, 2004b:2). Active prototyping & user interaction (Braa & Hedberg, 2002)</p>
<i>Development / Implementation</i>	<p>COTS software. External development (Scott et al., 2002) Offshore development in India, ISO9001 certified. Key focus was technical capability of HIS (state-of-the art, comprehensive, integrated- automating all areas of critical health care activity, end-to-end integration, cutting edge technology and</p>	<p>Enhancing IS to include community needs; stimulating reflection and use of community indicators; challenging inclusion of indicators; influencing higher level data collection systems; development of information culture for CHW (Byrne, 2004a). Active prototyping & user interaction. Implementing pilot projects. Implementation of national datasets.</p>

Process	Sapping	Vitalistic
	methodologies (open systems allowing interoperability, multimedia & image technology...) (MEDICOM, 2005).	Endorsement as a national standard. Informal mechanism for reporting bugs and requesting new functionality (Braa & Hedberg, 2002).

Table 2 Review of Approaches/Processes

Staffing and Skills

Key differences in staffing and skills between the case studies are whether local skills were used in the development and implementation, or whether foreign skills were used.

In (MEDICOM, 2005) skills such as project management, implementation, training and consulting were from a consortium of partners. Software development was done through an offshore development centre in India and there were no local developers/designers from the host organisation involved in the implementation.

In the Scott et al. (2002) study, external Geographic Information Systems (GIS) specialists were used, once again with no skills provided by the host organisation. Braa & Hedberg (2002) referred to specialist Microsoft Access developers being used; there was however good communication and rapid feedback between them and users of the system.

Local skills were used by the other two studies (Byrne, 2004b; Rotich et al., 2003) for prototyping, identifying information requirements and software development.

In all cases the researchers were external to the organisation, and in most cases (Byrne, 2004b; MEDICOM, 2005; Rotich et al., 2003; Scott et al., 2002) were involved in the implementation.

Impact of Staffing/Implementation Approach on Organisation

In the HISP study (Braa & Hedberg, 2002) the effect on the staff of the implementation was upskilling of personnel through training, greater involvement and increased responsibilities.

In the Rotich et al. (2003) study the effect was even more positive with providers' personal time increased by 30% with associated decrease in time spent with patients (50%) and a decrease in required interaction with other staff (75%) for providers and clerks. Clerks spent less time writing reports (15% less) and more time searching for information (2.5% more). There was a reduction in monthly reporting times to the ministry (2weeks--> minutes) which freed up two records clerks to perform other duties. As a result of the successes, the staff developed a sense of pride and ownership, and the ministry provided more staff.

The HIS did not impose an additional burden on health care providers to capture data by maintaining a paper based information system with checkboxes to feed the computer system.

The paradigm for staffing and skills is not clear; however it is evident that exceptional skills, rapid feedback/communication, and a response to client needs are important in implementing a successful, useable system that may have a positive impact. Increase in effectiveness and efficiency of staff also benefits the impact; however it should not be the primary motivation for the implementation of HIS.

Management Systems and Structures

As with the staffing and skills, the management and structures are not clear from the literature; however general trends can be identified.

In the majority of cases the host organisations were hierarchical bureaucracies with various levels of reporting. Except for the MEDICOM (2005) study which operated at a provincial level, all the organisations were at the lowest level of the organisational hierarchy (district or hospital) with Byrne (2004a) examining a HIS at the community level which is below district level. At the inception of the study, the information agents or Community Health Workers (CHW) were community members, but at the end of the study they were employed by the DoH.

The cases that had a positive impact on the organisation and community (Rotich et al., 2003) were engaging at the operational level with all stakeholders and were not part of the host organisation. In Braa & Hedberg (2002), interaction was at a district level.

The cases with a negative impact (MEDICOM, 2005; Scott et al., 2002) were interacting at a management or strategic level and experienced challenges such as “transformation required in a project of this complexity presented many hurdles which required close management” (MEDICOM, 2005).

The positive impact on management systems and structures was evident in the cases of HISP, CBIS & MMRS.

In the HISP study (Braa & Hedberg, 2002) the effect was a decentralised change in decision-making power regarding budgeting and management and improved information management at local level. The implementation of the DHIS resulted in equal control between central and local levels with local flexibility and user orientation simultaneously integrating vertical flows at district level. The system challenged existing organisational structures thereby empowering local management, health workers, communities, end and information users. The system is described as creating an enabling environment within a framework of standards. Despite this evidence of success, the initiative was never formally accepted by official structures.

In the MMRS study (Rotich et al., 2003) the effect was even more positive with information systems affecting how care is delivered, which in turn affects

how management and staff accept the system (positive feedback cycle). The system achieved an entry of more than 95% of data for visits and resulted in voluntary discontinuation of duplicate paper records (logbooks).

Resources (Time and Money)

Actual resource utilisation is not evident in the studies; however a few observations can be made.

Typically one would consider the cost of the software, licensing costs, incidental costs (travel, accommodation etc), the number of people involved and the period of the implementation (Glandon & Buck, 1994).

In determining HIS implementation costs in the public sector in SA, the resource utilisation of the host organisation is often not factored in, and is considered as a free cost. The majority of large scale implementations such as MEDICOM are tendered for as a fixed cost and time. Systems such as HISP are provided free of charge; however there are implementation and incidental costs involved.

The MEDICOM system (2005) was possibly the most expensive single implementation and probably utilised the largest team at a given time. The DHIS (Braa & Hedberg, 2002) will in the long term consume considerable resources in SA alone, with a number of people involved in the rollout to all district hospitals, and collaboration and training with educational and research institutions. Lack of sufficient external funding however remains a challenge.

The other implementations were all of a much smaller scale. In GIS (Scott et al., 2002) resource usage was effectively for the three researchers, one GIS developer and expenses over a period of 12 months as part of a Masters thesis. The Byrne (2004b) study involved a small group of people and no technology, but found that in the long term, the flexible approach is time and resource intensive and that the availability of people and the context affects the process, rate, and order of progression. The MMRS (Rotich et al., 2003) involved a small team of researchers (+- 8 people) and utilised a previously developed IS as the base platform.

It is not evident whether a low resource usage has a more positive impact than a high usage. It is however clear that a significant expenditure of resources does not necessarily provide greater benefit than a small scale implementation.

Society

In the case of the MEDICOM (2005) and GIS (Scott et al., 2002) implementation, the impact on society was minimal and primarily benefited the consortium of implementers, DoH, the researcher and/or the implementers of the system.

In the cases of HISP, MMRS & CBIS the impact on society was more evident.

The HISP (Braa & Hedberg, 2002:119) “constituted and reproduced the social relationships and contracts and the social fabric within the health service”. According to (Braa & Hedberg, 2002:125) “*the apartheid legacy also provided the political and social context within which change was enabled*”.

In the MMRS (Rotich et al.) study the HIS affected the patient visit duration dramatically with a 75% decrease (patients spent less than 42% time with provider and slightly more time for registration). Also, as a result of the information system, the hospital picked up cluster of STDs and a lack of immunisations and responded to these proactively.

The society members that benefited can be identified in the study as households, communities, health facility staff, community health workers, clinic health committees, traditional leaders, councillors, social workers, early childhood practitioners, mothers (including teenagers), fathers and grandmothers.

As a direct result of the MMRS, the MRHC was named as the top health centre in Kenya, and prompted a visit by the Minister of Health and Information Officers with the option of making the HIS a national standard.

Framework For Vitalistic HIS

When examining the case studies for the impact on society, two trends were clearly evident. The studies in which the focus was technology achieved exactly that, improved technology. In the studies where the focus was on enabling the organisation or improving society, the impact was more positive both on the organisation and society.

Detailed in Table 3 is a framework in which the vitalistic aspects (enabling positive impacts) from the preceding HIS case studies are contrasted with the sapping (disabling, negative impacts) aspects.

Impact	Sapping	Vitalistic
<i>Information</i>	Sickness & Disease (Epidemiology), information, restricted access, confirming and reinforcing power structures.	Health needs, used at source, free access, challenging power structures.
<i>Technology</i>	Centralised, specialised technologies. Focus on technology.	Distributed, PC-based technologies or no technologies (paper/ communication based). Technology as an enabler.
<i>Objectives and Values</i>	Efficiency, effectiveness, strategic alignment, and profitability. Aim of financial gain for vendor and/ or sponsor. Selling software	Providing an enabling context for health and wellbeing. Identifying information needs and supporting management teams.

Impact	Sapping	Vitalistic
	and services. Evaluation of software. Reduced costs. Values efficient use of resources and making money.	Values care for patients, sensitivity to cultures, improving work environment.
<i>Processes</i>		
Focus	Focus on organisational efficiency and effectiveness.	Focus on understanding the context and collecting and using information to improve health.
Participation	Limited stakeholder/organisational/end-user participation.	Significant collaboration and participation with funders, clients, educational institutions, communities, etc.
Involvement	Limited client, end-user and community involvement.	Mentoring and coaching, workshops, interviews, group discussions, meetings with communities, end/information users, funders, researchers, etc.
Design	Focus on technical capability and functionality of product; automating manual information.	Understanding of context (powers, traditions and customs, socio-economic conditions).
<i>Development</i>	Standardised IS, proprietary software, focus on system capabilities, waterfall implementation, limited user involvement, protracted change processes, infrequent updates.	Flexible IS, open software, active prototyping & user involvement, informal change process, rapid changes to software to cater for environment.
<i>Staffing and Skills</i>	Limited transfer of skills, frequent use of external resources, maintaining of duplicate systems, increased workload, forced changes in roles and responsibilities.	Upskilling of staff, greater involvement and increased responsibilities, increase in personal time, decrease in administrative communication overhead. No/limited burden on workload.
<i>Management Systems and Structures</i>	Entrenchment of existing structures, engages with political power base, used as a tool of power and control. Creates a disabling environment.	Changing of structures, engaging at operational level, decentralised change in decision making and budgeting, increased flexibility and devolved control, empowering management, health workers and communities.

Impact	Sapping	Vitalistic
		Creates an enabling environment.
<i>Resources (time & money)</i>	Large scale projects involving a number of people, little value derived from expenditure, long term implementation with no/limited results. Drain on resources (time and money). Funding continues despite failures or no visible successes.	Small scale implementations. Small teams of experts, value derived from small investments, often run on shoestring budgets, frequent milestones with visible results. Positive results ensure flow of funding.
<i>Society</i>	Minimal impact on society, primarily benefiting implementers or political agendas.	Facilitates interaction with society. Positive impact on health and service delivery. Identifies interventions proactively health.

Table 3 Framework for Vitalistic HIS

The negative factors are mainly targeted at technology or financial objectives and values in HIS implementation and often achieved just that. In addition it placed a drain (sap) on the the organisation in terms of funding and resources, with funding continuing despite limited success.

The major contributor to positive impact appears to be centred around the intention and values of the implementers, regardless of the paradigm used in implementation. Intentions of improving communication, empowering people and improving health and values of caring, sensitivity to cultures and improving environments had a positive impact on society regardless of the technologies or development approach.

CONCLUSION

There is currently no model or framework presented in the literature for evaluating or implementing vitalistic HIS in South Africa. This paper has set out to review five case studies in the fields of eHealth in Southern Africa in order to identify a framework for vitalistic HIS in SA.

The key findings are that there are factors contributing to negative impact (sapping) as well as positive impact (vitalistic) in these HIS implementations in Southern Africa.

The major contributor to the impact appears to be one centred around the objectives and values of the implementers, despite the paradigm used in appropriation.

Technology or financial objectives and values in HIS implementation often achieved just that and only that.

Objectives of improving communication, empowering people and improving health, and values of caring, sensitivity to cultures and improving environments had a positive impact on society regardless of the technologies or development approach.

It also appears as if systems that are funded or implemented by either vendors, or administrators, will most likely focus on, and serve the needs of the vendors/administrators. The same applies when the community or nurses are involved or implement the system.

Recommendations for Research

In order to ensure that HIS has a positive impact in South African health and healthcare, it is of prime importance to understand these factors that play a contributing role in the impact of the information systems. Once these factors are understood, then existing and future HIS implementations can be guided by them.

It is also important that this model be tested and extended in public eHealth evaluations and implementations in South Africa. These characteristics are specific for public health information systems in South Africa (and possibly in developing countries) and may not be applicable to private sector HIS or other countries.

However, merely being aware of these principles does not ensure that eHealth in South Africa will have a positive long-term impact on health and healthcare services. Repeating these practices and principles mechanistically may also not lead to a vitalistic health information system. What is important to realise is that these principles exist, and should be expanded and included in System Development Life Cycles (SDLC), education and training, and evaluation and appropriation of eHealth in South African public health.

Furthermore, the model could be developed to extend to general Information Systems practices in developing countries by including the concept of vitalistic information systems together with other practices such as strategic IS, management IS, and efficient and effective IS.

The application of these practices in a complex system such as the public health system in South Africa, may therefore require further research in order to examine the culture, paradigms, implementation, and delivery performance.

The framework should also be compared to other models for effective or sustainable IS development and/or impact of information systems implementations in developing countries.

Contribution

This research aims to provide a better understanding of the impact of the implementation of Health Information Systems in SA, both for the researcher, academia and practice. It is hoped that the research will aid in expanding existing

IS models/frameworks through the inclusion of vitalistic Information Systems as an accepted concept in developing countries.

Lastly the research aims to create an improved awareness in the Public Health Sector of the importance of vitalistic Health Information Systems.

Acknowledgments

The author wishes to acknowledge the role that INDEHELA has played in this research, the University of Cape Town for its excellent educational and electronic resources, as well as his father in law, for his editing and formatting of this paper.

References

- Addison, R.B. 1992. Grounded hermeneutic research. *Doing qualitative research*: 110-124.
- Ammenwerth, E., Winter, A., Brigl, B. & Haux, R. 2004. *Strategic Information Management in Hospitals: an introduction to hospital information systems*. Springer Verlag.
- Anderson, J.G. & Aydin, C.E. 2005. *Evaluating the organizational impact of health care information systems*. Springer.
- Baroudi, J.J. & Orlikowski, W.J. 1998. A short-form measure of user information satisfaction: A psychometric evaluation and notes on use. *Journal of Management Information Systems*. **4**(4): 44-59.
- Berne, E. 2004. *Games People Play: The Psychology of Human Relationships*. Penguin Books. UK.
- Booman, M., Sharp, B.L., Martin, C.L., Manjate, B., La Grange, J.J. & Durrheim, D.N. 2003. Enhancing malaria control using a computerised management system in southern Africa. *Malaria Journal*. **2**(13): 1-5.
- Braa, J. 2003. Integrated Masters Programs in Public Health and Information Systems - some lessons from South Africa, Mozambique, Tanzania, Malawi and Ethiopia. *Presentation at the Copenhagen DANIDA workshop (og Lygraseminaret litt senere!)*.
- Braa, J. & Hedberg, C. 2002. The Struggle for District-Based Health Information Systems in South Africa. *The Information Society*(18): 113-127.
- Brink, M. 1998. ILEX SA--Making a Contribution to Future Health Care. *South African Journal of Science*. **94**(11): 558-559.
- Bruce, J.C. 2002. Marrying modern health practices and technology with traditional practices: issues for the African continent. *International Nursing Review*. **49**: 161-167.
- Byrne, E. 2004a. Addressing the Vulnerability of Children through Information Systems: A South African Case Study. *Proceedings of SAICSIT 2004*: 33-43.
- Byrne, E. 2004b. Participatory Design of a Community-Based Child Health Information System in South Africa. *eGovernment for Development Information Exchange* [Online] Available: <http://www.e-devexchange.org/eGov/childhealthis.htm>.
- Chase-Dunn, C.K. 1991. *Global Formation: Structures of the World-Economy*. Blackwell.
- Cooperrider, D.L., Sorensen, P.F.J., Yaeger, T.F. & Whitney, D., Ed. 2001. *Appreciative Inquiry: An Emerging Direction for Organization Development*. Stipes Publishing L.L.C., Champaign IL.
- Crabtree, B.F.E. & Miller, W.L.E. 1992. *Doing Qualitative Research: Research Methods for Primary Care*. Sage Publications. California.
- Delaney, J. 2004. Innovation can cure infrastructural frailties. *Public Healthcare Magazine*. **1**(2): 17-19.
- Dennett, D.C. 1978. *Intentional systems*. Bradford Books. Montgometry, Vermont.

- Fernandes, A. 2004. Monitoring system for anti-retroviral treatment in South Africa. *Public Healthcare Magazine*. **1**: 12-13.
- Friedman, C.P. & Wyatt, J.C. 2005. *Evaluation Methods in Biomedical Informatics (Health Informatics)*. Springer-Verlag New York, Inc. Secaucus, NJ, USA.
- Glandon, G.L. & Buck, T.L. 1994. Cost-benefit analysis of medical information systems: a critique. *Evaluating Health Care information systems*. Newbury Park, CA, Sage.
- Harris, L. 2004. A decentralized DHS: easy in theory, difficult in practice. *Public Healthcare Magazine*. **1**: 10.
- Hedberg, C. 2003 Health Information Systems Progress with Caveats – an Integration Perspective 2003 South African Health Review - Health Systems Trust. DOI: [Online] Available: <http://www.hst.org.za/publications/423>.
- Heeks, R. 2002. Information Systems and Developing Countries: Failure, Success, and Local Improvisations. *The Information Society*. **18**(2): 101-112.
- Herbst, K., Littlejohns, P., Collinson, M. & Wyatt, J.C. 1999. Evaluating computerised health information systems: hardware, software and human ware: experiences from the Northern Province, South Africa. *Journal of Public Health Medicine*. **21**(3): 305-310.
- Jankowicz, A.D. 2000. *Business Research Projects*. Thompson Learning, Cornwall.
- Khotu, S.H. 2001. National Health Care Management Information System of South Africa. [Online] Available (June 13, 2005): <http://www.doh.gov.za/nhis/docs/nchmis.htm>
- Khumisi, O., Seopa, M. & Mokgabudi, A. 2002 NHC/MIS Workshop Report. DOI: [Online] Available: http://www.doh.gov.za/nhis/w-shops/nhcmis_report.pdf
- Klein, H.K. & Myers, M.D. 1999. A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*. **23**(1): 67-93.
- Korpela, M., Hanmer, L., De La Harpe, R., Macomed, E., Mursu, A. & Soriyan, H.A. 2004 How can African healthcare facilities get appropriate software? Sociotechnical research in the INDEHELA-Context project. *Unpublished working paper*, DOI: [Online] Available: <http://www.uku.fi/tike/his/indehela/inde-ITHC2004.pdf>.
- Language, K.E. 2004. Public Healthcare Magazine. *Systems Publishers*. **1**(2).
- Lerner, B. & Schiffman, R. 2004. Man or Machine: The Vitalistic Model of Health. [Online] Available (May 28, 2005): http://www.mercola.com/2004/nov/20/vitalism_health.htm
- Littlejohns, P., Wyatt, J.C. & Garvican, L. 2003. Evaluating computerised health information systems: hard lessons still to be learnt. *BMJ*.
- Mathews, V.E. 2003. Analysing the functions, roles and skills of District Information Officers in the implementation of the District Health Information System in South Africa. *Unpublished Masters Thesis at the University of the Western Cape*.
- Mbananga, N. & Sekokotla, D. 2002 The utilisation of Health Management Information in Mpumalanga Province. *Health Systems Trust*, DOI: [Online] Available (May 20, 2005): <http://www.hst.org.za>
- Medicom. 2005. An Enterprise-wide Implementation of a Hospital Information System. [Online] Available (May 25, 2005): <http://www.medicomsoft.com/images/pdf/gauteng.pdf>
- Mingers, J. 2001. Combining IS Research Methods: Towards a Pluralist Methodology. *Information Systems Research*. **12**(3): 240-259.
- Msp 2004. Gauteng Provincial Government (GPG), Department of Health (DOH) Master Systems Plan (MSP). *Unpublished strategic information systems plan done by CS Holdings., GPG DOH*.
- Neville, D., O'reilly, S., Macdonald, D., Farrell, G., Keough, M. & Gates, K. 2003. Measuring the Impact of Electronic Health Records Projects on Health Outcomes and Costs: An Evaluation Framework. *Abstr AcademyHealth Meet*: 20.
- Oh, H., Rizo, C., Enkin, M. & Jadad, A. 2005. What is eHealth (3): a systematic review of published definitions. *J Med Internet Res*. **7**(1): e1.
- PPP in Healthcare: Inkosi Albert Luthuli Central Hospital - SA. 2004, DOI: [Online] Available (May 25, 2005): <http://www.medicomsoft.com/>
- Rotich, J.K., Hannan, T.J., Smith, F.E., Bii, J., Odero, W.W., Vu, N., Mamlin, B.W., Mamlin, J.J., Einterz, R.M. & Tierney, W.M. 2003. Installing and Implementing a Computer-based Patient Record System in Sub-Saharan Africa: The Mosoriot Medical Record System. *Journal of the American Medical Informatics Association*. **10**(4): 295.

- Saunders, M., Lewis, P. & Thornhill, A. 2000. *Research Methods for Business Students*. Pearson Education Limited. Essex.
- Scott, D., Curtis, B. & Twumasi, F.O. 2002. Towards the creation of a health information system for cancer in KwaZulu-Natal, South Africa. *Health & Place*. **8**: 237-249.
- Sekaran, U. 2003. *Research Methods for Business: A Skill Building Approach*. John Wiley & Sons, Inc., New York.
- Simhan, R. 2002. Tapping health from hospital. Business Line: Internet Edition. [Online] Available (June 8, 2005): <http://www.blonnet.com/ew/2002/09/18/stories/2002091800290300.htm>
- Snyman, M. & Snyman, R. 2003. Getting information to disadvantaged rural communities: the centre approach. *SA Journal of Library and Information Science*. **69**(2): 95-107.
- Tanser, F., Hosegood, V., Benzler, J. & Solarsh, G. 2001. New approaches to spatially analyse primary health care usage patterns in rural South Africa. *Tropical Medicine and International Health*. **6**(10): 826-838.
- Van't Riet, A., Berg, M., Hiddema, F. & Sol, K. 2001. Meeting patients' needs with patient information systems: potential benefits of qualitative research methods. *Int J Med Inform.* **64**(1): 1-14.
- Wang, B.B., Wan, T.T.H., Burke, D.E., Bazzoli, G.J. & Lin, B.Y.J. 2005. Factors Influencing Health Information System Adoption in American Hospitals. *Health Care Management Review*. **30**(10): 44-51.
- What is eHealth?2006. [Online] Available: <http://www.ehealthtechnologies.com/what%20is%20ehealth.htm>
- Wikipedia. 2007. The Free Encyclopedia. [Online] Available: <http://www.wikipedia.org>
- Williamson, L., Stoops, N. & Heywood, A. 2001. Developing a district health information system in South Africa: a social process or technical solution? *Medinfo*. **10**: 773-777.

Designing our way to user understanding

Johann van der Merwe

Faculty of Informatics and Design, Cape Peninsula University of Technology,
Cape Town, South Africa

vandermerwejj@cput.ac.za

Abstract. This paper will present two main ideas: firstly, that the processes and narratives of interaction spaces are more important than the products themselves, and secondly, that the notion of identity formation can help designers of systems understand the possible actions that could result when user and system interact.

Keywords. Interaction spaces, communication skills, social narratives, identity formation.

Introduction

This paper serves a double purpose: to, firstly, introduce an international audience to the research focus of our faculty (essentially a merger between the Schools of Design and Informatics), which will serve as a general background to the rest of this paper, and subsequently to address one of the main issues of my own doctoral studies, namely the thorny question of a design identity. I will do so mainly by reviewing an article by Boland and Lyytinen (2004) in Part II.

Due to the educational merger (between the Cape Technikon and the Peninsula Technikon) that resulted in the Cape Peninsula University of Technology, the newly formed FID (Faculty of Informatics and Design) provided many unique research opportunities, both disciplinary and interdisciplinary. This also gave us a chance to reconfigure our collective research focus, and we soon realized that research into the relationship between knowledge and technology must also view 'technology' as any human system designed to classify and organize the world. In that sense our earliest 'technology' was the act of communication, followed by the use of tools, followed by the ability to print information. All of these are 'human technologies' designed specifically for

social interaction, and as such have culminated in the contemporary and ubiquitous use of all manner of computing technologies. Our research focus would then be concentrated on the use of all manner of 'technologies' specifically designed to facilitate Human-Information Interactions, as ways and means of strengthening the relationship between information generation, information storage, and knowledge creation, within socially constructed networks.

Part I: Thinking the new

As a research group we have chosen a methodological framework based on the social construction of reality, since industrial, interaction, and information systems designers, in general, agree with qualitative researchers on the need for research data that is sourced directly from the emerging needs and concerns of a specific social group or market. According to Denzin and Lincoln (1998:23, 30) a researcher is 'biographically situated' in doing interpretive work, which in turn assumes that people create and associate their own subjective and intersubjective meanings as they interact with the world around them and therefore attempt to understand phenomena through accessing the meanings that participants assign to them (Cushman and Venters, 2004; Denzin and Lincoln, 1997; Keeley, 2005; Myers, 1997; Orlikowski and Baroudi, 1991; Schneberger and Wade, 2006; Whitney, 2005).

Continuing this argument, Engeström's (2005) interactive design, based on activity theory, looks at both designed objects and people as embedded in the same dynamic social structure or activity system, and in this everyday practice, according to Nardi (1996), all human experiences are shaped by the tools, signs and systems used by them. The closely related ideas embodied by actor-network theory (ANT) are depicted by Tatnall and Gilding (1999) as not concentrating on the real differences between humans and machines (artifacts), but rather focusing on their interactions, viewing the social and technological 'properties' as "network effects rather than innate characteristics of an entity." Based on the work of Latour and Callon, Tatnall and Gilding view the world as filled with hybrid and co-existing **human and non-human entities**, and they state that actor-network theory can help resolve situations where these two entities cannot easily be separated and identified each in its own right, as if existing in isolation from one another.

These levels of complexity can further be dealt with, through a research framework based on Korpela et al. (2001), by making use of their proposed 2 x 4 integrative levels of analysis framework that considers the individual, group/activity, organizational and societal units of analysis (4) from both intra (within) and inter (between) viewpoints (2), with the latter providing for relational or comparative studies between units of analysis. According to this

framework, on the Individual Level HCI & design research needs the support of psychological theories and research methods; on the Group or Activity Level actor-network theory and particularly Engeström's activity theory is mentioned; on the Organizational Level use is made of organizational and business theories and frameworks, which invites the use of Soft Systems Methodology as devised by Peter Checkland; the Societal Level makes use of sociology and cross-cultural studies, and mention is made of the work of Castells, who described the emergence of a new space for social interaction, "comprised of interactions and the material infrastructure that makes these interactions possible" (Stalder, 2001).

Finally, Thompson (2002) "argued the need for locally relevant data collection methods ... designed in a bottoms-up way, to engage the whole person at the grass roots level in the process of data creation and interpretation" (quoted in Walsham and Sahay, 2005) - a clear need for a combination of activity and actor-network theory, indeed, for the application of grounded theoretical approaches that work on all levels of a complex societal infrastructure. We would do well to heed this call for more action research studies and locally based research projects situated in the developing countries themselves.

However, realizing the need for something and knowing how to go about achieving your goals is usually not such a straightforward exercise in logic. It was not that clear to us exactly how information and communication technologies plus design could best be used to promote or facilitate the interplay between the two fields. From this the main research question arose:

How can interaction spaces be designed to increase usability and usefulness?

ICT, or Information and Communications Technology, is a broad subject largely concerned with technology and other aspects of managing and processing information. Our research focus, however, dictates that these should be preceded by studies into the users' experience of social and working environments (Nardi, 1995), or socio-technical information infrastructures. We therefore prefer to use the collective term information communication product (ICP), being the product that evolves as part of an information infrastructure (II), continuously changing through its use and adaptation to its environment, thus bringing Informatics and Design closer together as research fields of inquiry.

At the same time we are conscious of the fact that information systems and the use of communication technologies, and specifically the so-called user interface whereby people and machines interact with each other, have changed quite rapidly over the last few years. As in design generally, so in Human-Information Interactions - wherever user interfaces are planned, designed and produced, the focus has shifted from a software / hardware efficiency goal, to the more complex human values and considerations that are expressed through basic

communication skills. In viewing the research theme of Human-Information Interactions from a social systems design perspective, we have to consider the 'natural' skills the user, in a social or work context, must be capable of, before considering any aspect of machine technology competence. If any information system, designed for, and meant to be used in a social context, **fails to deal with social constructs**, it becomes in itself an artificial construct based on mechanistic approaches, depending on human exclusion for both its conceptual origins and its material performance.

We therefore endorse the design approach that would have the 'technical invention' of any type of user interface working not only within the technology of electronic communication application, but, crucially, working towards the development of the skill of human communication, mediated and supported by any such device or system that could enhance contextual communication needs. Designers have been in danger of focusing too much on technical inventions or devices as if they were the original technology itself, whereas Raymond Williams (quoted in Jones, 1998) reminds us that any technology is supported by technical inventions, which are in turn designed to develop the original human skill, or the original 'technology' of social communication.

Given that background, it can be agreed that information systems (IS) and human computer interface (HCI) technologies are an essential part of what is seen as unparalleled technological development and that this technology can no longer be regarded as simply a resource but in many cases constitutes the working environment through complex technical systems (Löwgren, 2002; Saint-Onge and Armstrong, 2004: 2; Thakara, 2002, Yogesh, 1997). And yet, even though we may be surrounded by, and perfectly acclimatized to, ubiquitous computing and all manner of connective IS and HCI technologies, we may well ask, following John Thakara (2002), "To what question are they the answer?" If we accept Williams' concept of 'technology,' then the question becomes *What can augment and develop human communication skills?* That is the main reason why a research focus on Human-Information Interactions need to seriously take into account the consequences of these complex technical systems, since our ability to connect so easily can have significant implications in the long run (Saint-Onge and Armstrong, 2004: 2; Thakara, 2002), especially for developing countries.

In a White Paper for Intel, Sengupta et al. (2006) come to the conclusion that technological innovation will come about through focusing "instead on stories and accounts of ordinary people from a variety of places around the world." This agrees with Winograd (1997) who stated that only companies who were prepared to deal with the larger social contexts would be the ones to lead technological innovation, since there "is a complex interplay among technology, individual psychology, and social communication." Significantly, Mark van Doorn of Philips Research affirms that "many contemporary views on the future

of technology and business put the individual and his experience first” (Van Doorn, 2006).

This changed viewpoint allows us to engage with the larger social contexts in which interaction between IS, HCI, design, systems theory and end-user needs concentrate on new approaches that imbue machines not with human traits, but, through systems planning and co-creative design, will embody these ‘machined systems’ with the conceptual characteristics we can recognize as extensions of our own means of communication, and thus, vitally, reclaiming the larger social developmental and empowering context through these semiotic interfaces that would make not only accessing information easier, but facilitate the reconstruction of meaning within social and working environments (Mursu et al, 2004; Redström, 2005; Winograd, 1997).

In his address to a UK-Nordic Initiative on Information and Communication Technologies workshop, Anttiroiko (1999) deals “with the question whether the social sciences have developed adequate theories attending to social aspects of ICTs.” This notion of ‘adequate’ disciplinary theories is dealt with in Boland and Lyytinen’s *Information Systems Research as Design: Identity, Process, and Narrative* (2004). Like Design, the discipline of Information Systems seems to be struggling with an own identity that would differentiate it from any other, but reminiscent of personal identity, this is not possible, since the I depends very much on the presence (and identity/existence) of the Other. I fully agree with the authors that it is the process(es) inherent in the discipline that should determine its identity, and that to a large extent narrative plays a crucial role in this process. I also hasten to add that I fully endorse the context and the spirit of this paper, and only differ from Boland and Lyytinen in some respects of interpretation regarding the structuration of an identity.

Part II: Learning how to renew thinking

Boland and Lyytinen state that identity is a process that comes into being through the narratives of the language-games we all play a part in. Accordingly, we (they use the term to refer to researchers, but also to refer to technologies and actors in organizations as specific identity originators / creators) use the existing and meaningful narratives available in the world to build new meta-narratives, which then enter that same world as newly meaningful texts. This competitive situation means new texts compete with older meaningful texts thus affecting the emergence of yet further new meanings and understanding in the world. What we have to realize is that this scenario represents a three-fold involvement of meaning, and here we can refer to Turner and Fauconnier’s notion of conceptual integration or blending. The way we deal with the world and its proliferation of information / variety, is to tell stories, to conceptualize. We do so by using

language (playing language games), and by creating our own versions of what we imagine we are dealing with. "Since nobody can carry the physical world within himself, the process of conceptualization is indispensable to the process of structuring and ordering called communication" (Roelofse, 1987:12). Part of this conceptualization process is what Turner and Fauconnier (1995) call conceptual integration / blending, using mental spaces as natural constructions of normal cognition. During this process the input from two or more mental spaces (image schemas, abstractions, stories) are projected to a separate blended space, one that has elements of all the original inputs but that, crucially, now contains emergent structures not perceptible before. "Blending is at work in many areas of cognition and action, including metaphors, counterfactuals, and conceptual change" (Turner and Fauconnier, 1995), and blending is at work in Boland and Lyytinen's three-fold scenario.

Boland and Lyytinen's text, I feel, could have made this point (the ontology of identity) a little clearer, and they could have done so by, perhaps, not referring to meta-narratives, but rather using the literary notion of metafiction, since this idea comes closer to what Turner and Fauconnier means with blended storytelling. Seen in this light, the double-hermeneutics of the socio-technical world takes on a more practical identity, if you will. Meta-narratives normally refer to one dominating narrative, and as the term suggests, it is a story of reality that, while containing vestiges of the original stories it displaces, yet strives to control all forms of creativity and ontological processes. In contrast, metafiction refers to a virtual story that structurally, deliberately and methodically offers its own identity, as a questioning artefact, in order to highlight and interrogate the relationship between fiction and reality (Waugh, 1990:2). Thus when we use the existing, meaningful narratives in the world to help create our own narratives, the narrative structure that Boland and Lyytinen refer to *in itself* becomes a problem, although one can understand that type of narrative (and simultaneously, interpretative) structure as referring to an existing interpretation (of reality) being used to build new interpretations, which, in turn, affect other, and newer still, interpretations. Yet, and returning to the concept of a double-hermeneutics of the socio-technical world, the narrative structure needs to be seen as not a linear structure but as a more three-dimensional interdependent system that helps create a new story neither social nor technical, but a blend of both – an 'artefactual narrative' that draws attention to itself not as a device or system, but as a conceptual tool to question the relationship between the user and the interface (whatever form the latter may need to assume).

Strictly speaking, following Boland and Lyytinen's linear narrative structure, we would use existing narratives (meaning 1) to build our own identity-creating narratives (meaning 2), which in turn, as meta-narratives, affect the emergence of further meaning (3) and understanding. Here we have the researcher, but where does the user and the artefact / interface fit in? One would

assume that Boland and Lyytinen has the same three-fold involvement of meaning scenario in mind that Turner and Fauconnier's concept of integration points to, and yet the latter's explanation feels three-dimensional while the former's explanation still feels too much like linear cause and effect. Meaning (1) gives rise to meaning (2), which, as a meta-narrative, then gives rise to meaning (3). The very idea of identity construction should be seen as, not a *meta*-process, but a blended process, which makes quite a difference in the sense of not leaving behind the elements of origin, which is an impossible thing to conceptualize. Nothing is left behind, and in imagining (constructing the not-as-yet identity, if you will) the new we must not forget that, even when making use of the idea of going beyond (meta) original inputs, those origins are not superseded nor destroyed (or repressed, denied, banned, censored, etc.) but creatively transformed and augmented – hence the conceptual integration / blending process of identity or narrative creation. Boland and Lyytinen does mention the problem of our received vocabulary that must be resisted, and that we must understand the Wittgensteinian limits and traps of language, but are they not themselves caught in the snare of language convolution by insisting on going *beyond* (meta) what is there, instead of going *into* what is there, because *what is there*, at any moment, is all there is, until someone changes the situation, by means of a different way of 'seeing' *not beyond* the existing situation, but seeing, differently, *through-and-with* the existing situation. The new, whether an identity or a new design, cannot be achieved by going simply beyond what is there. This concept of *meta* is not the same as transcending what is there if, by using the language term meta/beyond we really mean *leave behind* meaning (1) to create meaning (2), which in turn then leaves behind both (1) & (2) in order to let (3) emerge: a very linear and loss-inducing process.

Perhaps Boland and Lyytinen did not mean to imply any of these interpretations of their text, but then, Wittgenstein (quoted in Arnheim, 1967:146) did say "... die Wörter sind wie die Haut auf einem tiefen Wasser" (words are like the skin on a deep pool); interpretation in depth means delving deep underneath the skin of *what is there*. As Wittgenstein (1968:43) put it, the essence of language lies not in the words themselves, or the visible 'rearrangement' of these black marks called writing, "but something that lies beneath the surface. Something that lies within, which we see when we look into the thing, and which an analysis digs out". The essence of the narrative lies not in *going beyond*, but lies in *going into*. The 'words' of the 'design text' that must be woven into the structure of the design narrative (whether this narrative needs to serve as an industrially designed object for everyday use or as an interface system) must be both the designer's and the user's 'words' or narrative, while at the same time this narrative belongs to neither. Meaning (1) plus meaning (2) is present, to be sure, but meaning (3) is the 'working narrative' the designer strives for yet cannot know fully, the not-yet-existing and future narrative that is not the result of cause-

and-effect linear thinking, but Turner and Fauconnier's complex blended projection of possible meaning, finally activated by the user.

The process of 'identity' formation based on a narrative structure is quite a complex one, and perhaps we need to take another look at Boland and Lyytinen's identity process using the narratives of our language-games: "... we build meta-narratives [*meaning 2*] ... of the narratives that are available in the world [*meaning 1*] ... and already full of meaning. But our meta-narratives [*meaning 2*] also enter that world as texts ... and thereby affect the way in which meaning and understanding [*meaning 3*] emerges in that world." My original objection to the use of the term meta-narrative still stands, but let us assume that this term may be interpreted to denote the newly constructed design narrative that the object or system has to be capable of communicating to the reader / user, and furthermore, that this narrative, while being 'communicated' – or, rather, revealed as an interpretative possibility, AKA user-activated 'solution' – can adapt or transform itself through interacting with signals from the (working) environment. The coming-into-being of this design narrative depends neither on the designer nor on the user as the final 'author' of its structure. An information systems solution using the notion of identity as narrative depends on a scenario of co-authorship, a scenario of co-designing, re-writing the design solution in real time. Any other solution is a closed system based on hard systems thinking, even when designed to be used in different work environments: a closed system embodies the thought processes of the designer but not those of the user, *perhaps because the latter becomes irrelevant to the way the system operates?*

Designing information systems cannot be done by constructing your own (research / design) identity first and then assuming that your (design) existential choices bring the socio-technical world into being. Boland and Lyytinen's text possible means the following: "... we build meta-narratives [designer/researcher: *meaning 2*] ... of the narratives that are available in the world [users: *meaning 1*] ... and already full of meaning. But our meta-narratives [designer/researcher: *meaning 2*] also enter that world as texts ... and thereby affect the way in which meaning and understanding [*meaning 3*] emerges in that world." Meaning (2) as a text is given far too much prominence, and researcher/designers are described as bringing the socio-technical world into being: what exactly does meaning (3) then consist of? The fundamental mistake being made by using hard systems thinking as opposed to soft systems thinking, is that meaning (2), when it appears the second time, should be seen as something else altogether: the 'designerly meaning' (*new meaning 3*) which is an amalgam of designer and user understanding of the specific problem space. We can re-write Boland and Lyytinen's text to read as follows: "... designers, in a process of professional identity construction, build narratives [*meaning 2*] ... using the narratives that are available in the world [*meaning 1*] ... and already full of meaning. But our design narratives [*meaning 2*] must combine with the existing narratives of the users

[*meaning 1*], and this newly created and combined understanding of the contextual problem space also enter that world as texts [*meaning 3*] ... and thereby affect the way in which meaning and understanding [*meaning 4*] emerges in the socio-technical world.”

We are, as the work of Niklas Luhmann makes clear, working with communications (narratives) based on what is entirely not there. Luhmann’s interpretation of an autopoietic or self-generating system is one that “constructs itself upon a foundation that is entirely *not there*” (Metcalf 1999), and the elements comprising the design narrative, the designer (*meaning 1*) and the user (*meaning 2*), construct not only their own ‘environments’ but *mutually* construct their social environment based entirely on what is in fact *not there*. Social reality and meaning is constructed inside the system, *inside the narrative*. So when Boland and Lyytinen “seek to characterize the recursive, dialectical process of our identity construction as it takes place within a social field as a set of knowledge production and dissemination practices ... that define what information system researchers are”, they seem to envisage the designer, again, as a social agent that needs an identity separate from that of the user, when, in fact, that should not, cannot be the case at all. A researcher has no identity in that sense. *There is no such thing as a designer*. Social communication means voluntarily giving up your individual rights to absolute certainty, and declaring your willingness to accommodate the other. In that sense there can be no such thing as an individual personality *sans* any formative social background, or a designer divorced from that which is being designed for: the contextual social world. A designer must work with the personality, the identity, the essence of the user’s landscape or narrative of reality, and not with his own ‘identity’. All this happens inside the narrative, inside something that is *entirely not there*, therefore it can be done: anything that can be imagined with empathy can be constructed in a social reality landscape.

I mentioned my unease with the use of terms such as *meta-narrative* (going beyond narrative), and Boland and Lyytinen’s insistence on the identity of the researcher / designer (that comes to the fore when they discuss (pp.61-62) narratives options) highlights the use of another term that is quite puzzling. Based on Bruner’s notion of the subjunctive process, Boland and Lyytinen view this subjunctive power as allowing us to be *trapped* in the narratives we construct. “In following any of these paths, we are relinquishing our own identity construction to a residue of the past ... we run the risk of losing our own identity by serving the structurational narratives of another.” I can only repeat: you have no fixed ‘identity’ to lose, and therefore the whole point is to ‘subsume’ yourself. Words such as *domination* and *trapped* should have no meaning in this new design narrative. On the contrary, one could look at a different viewpoint that does not recognize entrapment, but focuses on creation. The following section was written for another conference (van der Merwe, 2007), but is included here because of its

relevance to how identities are ‘designed’ – the designer, user, and social identities we have to contend with.

Reassembling the self through a new ethics of negotiation

If the *out there* of an ‘objective’ world does not exist, then so too this strange creature called *the social*, thought of as if it were a culturally contrived member of the human club. As designers we have to follow the constructivist example of artificially designed realities, and realize that we cannot deal with an unproblematic ‘objective’ world *out there* as if that were all there is to life and experience. Latour (2005) reminds us that ‘the social’ cannot be seen as a specific domain of reality, but that the associations we enter into, the connections we make and the consequent results specify anew each time what ‘the social’ can become: “I am going to define the social ... only as a very peculiar movement of re-association and reassembling.” This reads very much like design itself, since design, as a social act, must be redefined, in a particular but peculiar (atypical) context, every time the process is started, anew. As for the sociology of the design user, this same argument is valid: *I am going to define the design user ... only as a very peculiar (atypical) coming-into-being (movement) of re-association and reassembling*. Our real existence, the reassembling of our real selves, happens during the communicative ‘movements’ we experience when *in here* and *out there* interact *and communicate*: what we think we are, what we fondly regard as our real identity, has to come into contact with ‘the world’ where we encounter other identities and designed objects.

Communication, seen this way, is a negotiation and a making of meaning, and *we* are responsible, as long as it can be admitted that ‘we’ are made up of **human and non-human actors**, plus the consequent actions resulting from these communicative interactions. ‘We’ can shape the future by means of these acts of meaning-making. In asking the question, *how does design shape the future*, we are really asking how the collaborative ‘we’ can deal with the contemporary, but also the future, sense-making, world. What cannot be forgotten, is that the so-called objective world only shows the traces of past decisions and actions, and it is very easy to fall into the trap of ‘that is how things are’ because of ‘that is what the system is like,’ instead of knowing that ‘the (social) system’ is in fact constituted *in the future*, while we speak and negotiate. What cannot be allowed to be forgotten is the power of language, and specifically the power of the subjunctive.

What if, and *as if*, and *just imagine if*; these are expressions of the coming-into-being of the future. Eco (2000) is not the only one to believe we are in danger of losing the use of the subjunctive, a verb form that refers to possible actions and not factual ones, and the conceptual tool that allows us to speak into the future. *What if* we were to lose this ability? Design itself and the creation of a personal ontology – *not* a factual account of existence or the number crunching numbness of past achievements, but the coming-into-being of a new and possible

other-self – is a negotiation between what you think you are now, the elements you choose to include in your ‘knowing’ environment, the people and knowledge you surround yourself with, plus this act of faith (in yourself), that your peculiar mix will result in a better future. Without the power of our language to project into the future, we would be stuck in the factual present, and not achieve what Krippendorff (2006) calls the semantic turn, “a seed for design to redesign itself by means of its own discourse.” This ‘intrinsically motivating’ process helps people to get to know themselves, helps designers to validate the changing modes of contemporary being. This carries a great responsibility, since a normative and therefore ethical dimension is added.

Herkert (2002) speaks of the growing awareness of ethics as an educationally sensitive issue. As a design issue, certain commentators focus on the systemic activity that is the design process, and see ethical responsibility as:

... more than [being individually truthful] ... something much more than making wise choices ... Our moral obligations must ... include a willingness to engage others in the difficult work of defining the crucial choices that confront technological society ... (Herkert, 2002)

To make matters worse, Dorst and Royakkers (2006) state that, when it comes to questions of ethical methodology, we seem to lack conviction that a workable answer can be found. Caroline Whitbeck, on the other hand, suggests a design analogy in her book *Ethics in Engineering Practice and Research*. Questions of ethics cannot be left to analytical foundations seeking prescriptive moral principles, since, thanks to the design analogy (meaning, really, thanks to comparison with the real world of action), we are forced to deal with ill-structured problem situations that conform to no solution recipe and admit of several outcome possibilities (Dorst and Royakkers, 2006). In this world of uncertainty filled with complex situations, addressing ethics directly makes no sense since we will fall back into the reductive approach Whitbeck warns us about. Instead, we could look for examples of systemic thinking, such as Spinoza’s belief that self-preservation, an understanding of one’s own circumstances, will lead to moral decisions (Russell, 1987).

This agrees with Wittgenstein’s viewpoint that morality, revealed through peoples’ actions, cannot be subjected to any reductive analysis (Edmonds and Eidinow, 2001). Just as Heidegger’s *Being* (1962) will not let itself be expressed directly, so what we are pleased to call ethics cannot really be brought to light in direct everyday expression, except through human actions, and therefore through the consequences of the choices each individual makes. In that sense von Foerster (1991) sees metaphysics as that which happens when we find ourselves making decisions about what he calls *in principle undecidable questions*. This is something I can understand, and it correlates with Jacques Maritain’s belief that

we should live according to the “logic of the structure of the living thing”, not the logic of decidability, or what Maritain (1939) called the pseudo-logic of clear ideas (i.e. positivism). Von Foerster is correct, and not alone, in pointing to the ethical character of metaphysical undecidable questions that we attempt to answer by making the ultimate philosophical choice, when we decide to be what we can become and take full responsibility for that decision.

When designers make that decision, when they take the responsibility for a product’s ontology, what it can become, and knowing the possible social consequences due to its non-human role-playing capacity, then *that* can be described as an ethical decision. The design process, spurred on by ill-structured problem environments that offer contradictory ‘evidences,’ can only find a solution *during* the process, and only by a method of inclusiveness that fully engages those other human as well as non-human actors that can have a bearing on the *social direction* the solution is taking on. For Whitbeck the design analogy works because, to wildly paraphrase Dorst and Royackers (2006), moral acting is that process that lets the moral problem unfold itself in company of the coming-into-being of new options, for becoming, for making a decision. This is so close to Heidegger’s *Dasein* (everyday human existence) that should strive for *Being* (an ultimate and possible, better, mode of existence) that a design theorist can recognise the applicability of this type of phenomenological metaphysics, or, rather, recognise the switching that takes place between the two ‘realities’ of the worldly *here* and the virtual, conceptual, *there*. Designers can be in two places at the same time, because this is a normal human ontological coming-into-being process that uses all possible realities, including those of other people and those that can be suggested by all the non-human actors we call designed objects.

Back to Boland and Lyytinen

I agree with the general tone of Boland and Lyytinen’s article, but “reading between the lines” (p.61), and their interpretation of the subjunctive power of interpretation leads me to think that Boland and Lyytinen are conflating two mindsets and trying to control what cannot be controlled, or, what should not be controlled by the ‘wrong’ social agent. The only ‘control’ that is applicable in constructing a design narrative is the notion of the regulatory process of *intrinsic* control, which “sees to it that Ashby’s Law [of Requisite Variety] is automatically obeyed; therefore there is no loss possible in balancing the variety equations” (Beer, 1979:91). The way we deal with the world and its proliferation of information / variety, is to tell stories, to conceptualize and project, in short, to mentally structure the regulatory process of *intrinsic* control. We do so by using language (playing language games), and by creating our own versions of what we imagine we are dealing with. Designers of information systems, however, do not choose the narratives, nor do the users, because the narratives we should be

concentrating on are the yet-to-be ones that are *entirely not there*, yet. No one can control these, nor should they set goals and objectives by trying to avoid *appropriation* or the *alignment* with not-my-own narratives. Boland and Lyytinen's choice of words, the existential choices they speak of making, already set the scene for confrontation rather than true dialogue with the other-of-designer.

I would far rather return to the notion of metafiction, which refers to a fictional story that structurally, deliberately and methodically offers its own identity, as a questioning artefact, in order to highlight and interrogate the relationship between fiction and reality (Waugh, 1990:2). If we translate this idea, it becomes what Gerhard Fischer (2003) calls meta-design. Waugh's description of the role that metafiction can play is very adaptable to design thinking: *meta-design refers to a design narrative that structurally, deliberately and methodically offers its own identity, as a questioning artefact, in order to highlight and interrogate the relationship between user narratives and reality*. Fischer writes that "a fundamental objective of meta-design is to create socio-technical environments that empower users to engage in informed participation rather than being restricted to the use of existing systems". The use of narratives in design must, I believe, follow this fundamental reasoning: to create a socio-technical world, that does not yet exist and only begins to 'exist', at first, as an entirely-not-there narrative, we must focus on the interactive spaces-for-use that can be co-created and understood by the user, and, crucially, can offer itself (as 'artefactual space') up as an interpretative tool for further 'design' / development.

Conclusion

Our faculty research niche area emphasizes the design of interaction spaces that can increase their usability and usefulness. We therefore concentrate not so much on the things (designed objects) themselves as on the processes inherent in our respective disciplines of Design and Informatics. The practical research being done continuously by designers and programmers is vitally necessary, granted, but without the normative social content *and* context these sometime amazing achievements become mere technical litter, non-human actors/systems that detract from the everyday working and cultural life of real people. Interface design should not mean *in your face*, as so many of these technical productions-sans-user-input turn out to be. As a research group we realise that what we should be producing is nothing more nor less than these *interaction spaces for human use*, being the most relevant and important element of the whole designed system, within which the product, the user and the interaction each play a role. These interaction spaces signify something *entirely-not-there*, being virtual spaces that have yet to be activated by the user interacting with the product, working within systems, working within professional/cultural environment.

Given this scenario, it becomes important to look into the narrative(s) being formed, in real time, every time, between the user, the product, the environment in which the interaction is taking place, and, of course, the designer, albeit in a 'minor' capacity (not being physically present). The cognitive and ontological aspects of identity formation can help designers to, firstly, understand their own processes as creative people, and only then, secondly, help them understand how the user could possibly interact with the product(s) and systems these designers (as understanding-people) develop, based on, not their own interpretations of how things are or should be, but based on a co-production of socially constructed meaning. It is my firm belief, and the focus of my research project, that this notion of a working and adaptive identity lies at the heart of knowing yourself, and therefore 'knowing' your discipline.

References

- Anttiroiko, A. 1999. *Remarks on the Relation Between Social Science and ICT*.
<http://www.uta.fi/~kuaran/nordic.html>
- Arnheim, R. 1967. *Toward a Psychology of Art*. Berkeley: University of California Press.
- Beer, S. 1979. *The Heart of Enterprise*. Chichester: John Wiley.
- Boland, R., and Lyytinen, K. (2004). "Information Systems Research as Design: Identity, Process and narrative", in IFIP WG 8.2 Conference Proceedings *Relevant Theory and Informed Practice: looking forward from a 20 year perspective on IS research*, pp. 53-68, July 15-17, Manchester, U.K.
- Cushman M & Venters W 2004 *Making Sense of Rich Pictures: Combining SSM and Oval Mapping*.
http://personal.lse.ac.uk/cushman/papers/SSM_OMT%20methodology.pdf
- Denzin, N.K. and Lincoln, Y.S. (1998). "Introduction: Entering the Field of Qualitative Research", in Norman K. Denzin & Yvonna S. Lincoln (eds.) *The Landscape of Qualitative Research*.
- Dorst, K. and Royakkers, L. (2006). "The design analogy: a model for moral problem solving", *Design Issues*, 2006, (27)6, 633-656.
- Eco, U. (2000). "Signs of the Times", in David, C., Lenoir, F. and de Tonnac, F., (eds.) *Conversations About the End of Time*. Penguin, London.
- Edmonds, D. and Eidinow, J. (2001). *Wittgenstein's Poker*. Faber and Faber, London.
- Engeström, Y. (2005). *Activity Theory and Expansive Design*.
http://projectsfinal.interaction-ivrea.it/.../ACTIVITY%20THEORY%20AND%20EXPANSIVE%20DESIGN_Engestrom.pdf
- Fischer, G. (2003). *Meta-Design: Beyond User-Centred and Participatory Design*.
<http://www.cs.colorado.edu/~gerhard/papers/hci2003/-meta-design.pdf>
- Heidegger, M. (1962). *Being and Time*. Harper Collins, New York.
- Herkert, J.R. (2002). "Continuing and Emerging Issues in Engineering Ethics Education", *The Bridge*, 2002, 32(3) – Fall.
<http://www.grainingerchallenge.com/nae/bridgecom.nsf/weblinks/MKEZ-5F7SA4?OpenDocument> [2007/03/09].

- Jones, P. (1998). "The Technology Is Not the Cultural Form? Raymond Williams's Sociological Critique of Marshall McLuhan", *Canadian Journal of Communications* (23)4.
<http://info.wlu.ca/~wwwpress/jrls/cjc/Backissues/23.4/jones.html>
- Keeley, L. (2005). "The Emergence of New Innovation Disciplines," in *Perspectives on Design + Strategy*, Points of view from the 2005 Institute of Design Strategy Conference, Institute of Design, Illinois Institute of Technology.
http://www.id.iit.edu/papers/IDSCbook_excerpt.pdf
- Korpela, M., Mursu, A., and Soriyan, H.A. 2001. "Two times four integrative levels of analysis: a framework", in Russo NL, Fitzgerald B, DeGross JI, (eds.) *Realigning Research and Practice in Information Systems Development, The Social and Organizational Perspective, IFIP TC8/WG8.2 Working Conference*, Boise, Idaho, USA, July 27-29, 2001, p. 367-377. Boston: Kluwer Academic.
- Krippendorff, K. (2006). *The Semantic Turn: A new foundation for design*. Taylor & Francis, Boca Raton, FL.
- Latour, B. (2005). *Reassembling the Social*. Oxford University Press, Oxford.
- Löwgren, J. 2002. *Just How Far Beyond HCI is Interaction Design?*
http://www.boxesandarrows.com/archives/just_how_far_beyond_hci_is_interaction_design
- Maritain, J. (1939). *Art and Scholasticism*. Sheed & Ward, London.
- Metcalf, G.S. (1999). *A Critique of Social Systems Theory*,
http://hypernews.ngdc.noaa.gov/hnxtra/Metcalf_paper.html [2002/12].
- Mursu, A., Korpela, M., and Soriyan, A. 2004. "A Generic Framework For Analyzing the Sustainability of Information Systems", in Proceedings of the Americas Conference on Information Systems, New York, New York, August 2004.
- Myers, M.D. 1997. *Qualitative Research in Information Systems*.
<http://www.qual.auckland.ac.nz/>
- Nardi, B. A. (ed.). 1996. *Context and consciousness: activity theory and human-computer interaction*. MIT Press, Cambridge, MA.
- Orlikowski W.J., Baroudi J. J. (1991) "Studying information technology in organizations: research approaches and assumptions", *Information Systems Research* (2)1, The Institute of Management Sciences.
- Redström, J. 2005. *Towards user design? On the shift from object to user as the subject of design*.
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2K-4GX64W0-1
- Roelofse, J.J. (1987). *Signs and Significance*. Lexicon, Johannesburg.
- Russell, B. (1987). *A History of Western Philosophy*. George Allen & Unwin, London.
- Saint-Onge, H. & Armstrong, C. 2004. *The Conductive Organization*. Amsterdam: Elsevier.
- Schneberger, S. and Wade, M. (eds.) 2006. *Theories Used in IS Research*.
<http://www.istheory.yorku.ca/>
- Sengupta, U., Sherry, J., and Hills, B. 2006. *Intel White Paper: A User-Focused Technology Vision for 2015*. <http://www.intel.com/technology/architecture/vision2015/index.htm>
- Stalder, F. 2001. *The Space of Flows: notes on emergence, characteristics and possible impact on physical space*. http://felix.openflows.org/html/space_of_flows.html
- Tatnall, A. and Gilding, A. 1999. *Actor-Network Theory and Information Systems Research*.
<http://www.vuw.ac.nz/acis99/Papers/PaperTatnall-069.pdf>
- Thakara, J. 2002. "The philosophy of systems literacy in design", in *Flow*, Proceedings of the Doors of Perception 7 Conference, Amsterdam, 14-16 November 2002.
- Turner, M. and Fauconnier, G. (1995). *Conceptual Integration and Formal Expression*.
<http://philosophy.uoregon.edu/metaphor/turner.htm> [2004/10/18].
- Van der Merwe, J. 2007. "Ontologically Shaping our Future: Design Education as Revelation", in *International Conference on Engineering and Product Design Education*, 13-14 September, Northumbria University, Newcastle Upon Tyne, UK.

- Von Foerster, H. (1991). *Ethics and Second-Order Cybernetics*.
<http://grace.evergreen.edu/~arunc/texts/cybernetics/heinz/ethics.pdf> [2006/10/24].
- Walsham G., and Sahay, S.2005. *Research on Information Systems in Developing Countries: Current Landscape and Future Prospects*.
<http://heim.ifi.uio.no/~sundeeps/publications/ResearchOnISInDeveloping.pdf>
- Waugh, P. (1990). *Metafiction: The Theory and Practice of Self-conscious Fiction*. Routledge, London.
- Whitney, P. (2005). "Strategic Design", in *Perspectives on Design + Strategy*, Points of view from the 2005 Institute of Design Strategy Conference, Institute of Design, Illinois Institute of Technology.
http://www.id.iit.edu/papers/IDSCbook_excerpt.pdf
- Winograd, T. (1997). *From Computing Machinery to Interaction Design*.
<http://hci.stanford.edu/~winograd/acm97.html> [2006/03/17].
- Wittgenstein, L. (1968). *Philosophical Investigations*. (trl.) G.E.M. Anscombe. Blackwell, Oxford.
- Yogesh, M. (1993). "Role of Information Technology", in *Managing Organizational Change and Organizational Interdependence*. <http://www.kmbook.com/change>

Organizational implementation in crisis: The role of the information system

Anne Forsell, Helena Karsten and Riikka Vuokko

University of Turku, Department of Information Technology and TUCS

piukku@utu.fi, eijkar@utu.fi, riirvu@utu.fi

Abstract. Implementation of a new information system in a hospital environment has often proved to be problematic or even risky. Working in a hospital environment is characterised by complex and intertwined action between, for example, the staff, technology and organizational units. This paper describes an implementation case in a university hospital, where an electronic patient record system was introduced in a surgical clinic. During the organizational implementation, a multitude of socio-technical issues emerged. The nurses named this situation a crisis. This crisis is analysed with the issue order model introduced by Star and Ruhleder (1996). The preliminary results already indicate that not only the new technology, but also social structures, such as interpreting the EPR use in the hospital, influences the emergence of problems.

Keywords. Electronic patient record, Implementation, Social structures, Issue order.

Introduction

Implementation of an information system usually causes changes also in work practices. This is not an automatic feature of a new system, but rather a feature of the socio-technical environment of use in organizations (e.g. Lamb and Sawyer, 2005; Orlikowski and Gash, 1994). Users of the information system may need to learn new tasks or processes, and some of the previous work practices or working knowledge may even become outdated in the new situation (Nonaka and Takeuchi, 1995; Star and Ruhleder, 1996).

Berg (2001, 2004) and Jones (2003) have shown that implementation projects in a hospital environment are often problematic or risky. For example, Scott et al

(2005) describe an implementation case where the implemented electronic medical record was withdrawn from use due to users' resistance, reduced productivity, and technical problems. Organizational development situations are often characterised as phases of, for example, political conflict (Latour, 1987; Woolgar, 1991) or re-structuration of technology-in-use (Orlikowski, 1992, 1996). In this implementation case, the nursing personnel and the doctors themselves called the change situation a crisis or as one of the implementation project members put it: "The crisis was such a huge thing that some of the users hoped for the discontinuation of the whole implementation."

For the case study, we define crisis to be a turning point during the implementation project, or "a time of great danger, difficulty or uncertainty when problems must be solved or important decisions must be made" (Oxford English Dictionary). In this study, the crisis seemed to be a turning point that affected most of the future users or user groups of the information system. The case showed that a new, unfamiliar information system can be accused of shortcomings or problems that may not actually be caused by the technology. In a crisis situation it is human to find a "scapegoat" that can be accused. Instead of simply labelling the new information system as a "scapegoat", we want to ask, if the implementation of an information system is a catalyst that makes it possible for other socio-technical issues and problems to emerge in the organizational context. Therefore the main research question in this study is: What is the role of the information system being implemented in the emerging problems? We aim to describe the organizational conditions that can trigger the emergence of these problems, and how the conflicting features could be noticed up front in order to solve the issues as early as possible.

The case study describes the implementation of an electronic patient record system (later EPR) in a university hospital where the implementation was carried out in two of the surgical units during November 2005. This implementation ended up in a problem situation that had to be solved before the working atmosphere in the surgical clinic could improve. This crisis was brought about by multiple and intertwined socio-technical issues.

Stakeholders in the problematic situation were the executive group of the EPR project; the doctors and nurses working in the surgical clinic; the hospital representatives, and the software vendor. To understand the hospital environment as a context of working, previous research in the same hospital was scrutinized. Karsten and Laine (2006) have documented the first impressions during the implementation of EPR by using technological frame analysis by Orlikowski and Gash (1994). We gathered a new set of qualitative study data by interviewing the members of surgical units during spring and summer 2006.

This paper is organized as follows. First, we summarize some main features of the previous implementation studies in hospitals and their large information systems. Then we introduce our theoretical framework based on the issue order

model by Star and Ruhleder (1996) and the methodological background of data gathering and analysis in the hospital case. Then, the preliminary results of the analysis are given, and their nature is discussed with some concluding remarks.

Implementation issues in hospitals

Implementation of large hospital information systems is described by various authors as a problematic phenomenon, and shortcomings of such implementations are documented to help repeating the same mistakes in the future implementations (e.g. Berg, 2001; Jones, 2003). In their hospital study, Karsten and Laine (2006) described the implementation of an information system from the viewpoint of the users, and they argued that uncertainty is one typical feature when a new information system is introduced. To illustrate the uncertainty vs. continuity, we have adopted the view of social structures as both enabling and constraining actions (Giddens, 1979, 1984; Jones and Karsten, 2003). According to Giddens (1984), the duality of structure can be observed in action: social structures, such as rules and resources, influence our action, and on the other hand, the actions we take influence the re-generation of social structures and practises. Social structures are not stable but they are constantly being re-generated through people's actions. In contrast to continuous change, repeating routines brings ontological security – that is a feeling of continuation – to the daily living (Giddens, 1984; Jones et al, 2004).

Tensions caused by uncertainty and continuous change are present in Berg's (1999, 2001, 2004) writings, where he describes large information system implementations in various hospital environments. Berg argues that success stories in the hospital implementation projects are more uncommon than the stories of less successful implementations. According to Berg (1999), most of the studies aim to described success and benefits of the implementation projects than uncertainty and problem issues that may have been encountered. One reason for the failures in the hospital implementation projects is that the social environment of working has received far too little attention in systems design (e.g. Berg, 1999; Berg et al, 1998). An information system with sophisticated functions can be a poor choice for its future context of use, if the natural working order or the workers' practices have not been considered at all during the system development phase (Hougham, 1996).

It is typical that a new information system is resisted (Markus, 1983; Zuboff, 1988) by its users when the use is not yet learned and fluent (Star and Ruhleder, 1996; Orlikowski and Gash, 1996). Berg et al (1998) enlighten the situation where resistance increases by the users as their opinions and attitudes are not listened to or respected, first during the system design and later during the implementation. In

this hospital case the use of the EPR-system was discontinued due to the user resistance, as we later describe.

Jones (2003) argues that the resistance of information system use decreases as the users learn to use the system more fluently and in a more routine way. In our case study, the implementation was still going on and, for example, training sessions were held but no routine use of the new system was yet apparent. According to Jones (2003) learning to use an information system occurs even when the system is inconvenient and complicated for carrying out a particular task or when the system usability is not sufficient. Through learning and familiarizing the new system, its use becomes a habit and a routine. To continue, Jones (2003) describes differences between the physicians' and nurses' use of information technology. In his study, physicians were more ready to enlighten the shortcomings or failures in the new system, and they could even decline to use the system altogether whereas nurses typically became used to the system despite its possible shortcomings. We noticed similar differences, as described later.

Jones (2003) summarizes that the user-resistance is more typical for users who are satisfied with their current information system in use, whereas users of older and slower systems are more eager for the change and emphasize more readily the positive features of a new, advanced information systems. This conclusion by Jones's studies led us – wrongly – to believe that in our hospital case, the implementation of the EPR could be a long awaited new feature in the hospital working environment where previously patient records were kept manually and with considerable effort. Thus we expected that fairly mild user resistance would be encountered.

Sahay and Robey (1996), however, emphasise that the implementation of an information system can be a smooth process, if the working conditions and practices stay as relatively similar to the situation before the implementation. In our case, the patient documentation practices were expected to change. It is still uncertain how the EPR documenting practices have influenced other arrangements in nursing. Star and Ruhleder (1996) argue that the tension during implementation project is caused by the contradiction between the various users' local and fluently adapted use of information system, and the organizational need for standardizing and ensuring continuation on a more abstract level of use. Our case study illustrates also the aspects of different interpretations by, for example, the nurses and the hospital management.

The issue order model

Star and Ruhleder (1996) studied an implementation case of a large information system, and how such implementation affected the various organizational units of action or different stakeholders with varied capacity for information system use.

They compared impacts of information system use to the duality concept that was introduced in structuration theory: a new information system can either enable or constrain changes in the environment of working. The new information system can cause various adapting or conciliatory actions, which then affect already existing working practices and standards in the future.

Star and Ruhleder (1996) were inspired by Bateson's model of learning (1978) in building their model. Bateson researched how there are communication gaps between different levels of learning, or constructing knowledge and how these gaps hinder learning. Nonaka and Takeuchi (1995) emphasize Bateson's (1979) view that "information" differs from "knowledge", but that information is needed for creating knowledge of, for example, new technical features. Nonaka and Takeuchi (1995, p. 58) conclude that "information is a necessary medium or material for eliciting and constructing knowledge." Before the members of surgical clinic can learn to use the EPR, before they become knowledgeable users of the new system, they have to receive enough information about its functions in order to interpret and fit it into their own working context. In the model by Star and Ruhleder (1996), the technical infrastructure provides the context for communication, learning, and distributing information. In this approach, information systems, actors, and work tasks and processes form together an infrastructure that either works or breaks down. Star and Ruhleder identified three levels of issues in their analysis of problems within the implementation case that they were studying. In the following, we summarize these three issue orders.

First order issues are the ones that are quite easily solved by re-allocation of resources. These problems are often easily visible and solutions to them are practical in nature. First order problems concern, for example, getting user accounts, connecting or putting up the system, learning the basic use of the system, or arranging user training. Typical first order problems are related to everyday situations, such as how the system should be used and how it is used.

Second order issues can be caused, according to Star and Ruhleder (1996, p. 118), by "unforeseen or unknowable contextual effects" – that is collision or combinations of two or more first order issues. Second order issues are often unexpected by nature because they emerge as secondary effects after the implementation. These unexpected effects may be caused, for example, by technical choices made or by the differences between the various cultures of practice that are working together in the implementation. Generally the uncertainty that is present during implementation of information systems is also considered a second order problem.

Third order issues are often political or social by nature. Their nature means that these problems are also hard to solve. For example, such problems can be the caused by the historical reasons behind the choices made in the implementation project or distinct features in the organizational culture. Star and Ruhleder (1996)

note that the differences between various disciplines or viewpoints can have a nature of permanent disputes.

According to Star and Ruhleder (1996) the three levels of issues are not unambiguous as various problems can be inspected on different levels by stakeholders. Relations between different problematic or conflicting issues or even double binds (Bateson, 1978; Star and Ruhleder, 1996) can be affected also by how the members of user groups identify these problems. According to Star and Ruhleder (1996, p. 118), double binds in information system implementation are situations that cause constant discordance amongst the users of the system, and can cause “organizations which are split and confused, systems which are unused or circumvented.” In order to avoid development of such situations, it is important to understand the intertwined nature of issues in organizational implementation.

The issue order model or the concept of double binds has been rarely discussed or used as analysis tool in later research although Star’s and Ruhleder’s (1996) article is much cited (Barrett and Walsham, 2004). Even Star (Bishop et al, 2000) herself has later modified the definition of the three issue levels. In the later definition (Bishop et al, 2000) the first order issues are simple such as getting the system running, the second order issues contain abstract choices that the users need to make, and the third order issues are described as political or philosophical. An example of third order philosophical question is negotiations about the value of functions in the information system. In this study we aim to adhere to the original definitions of the issue levels (Star and Ruhleder 1996).

Issue order model can be used to describe contextual problem situations emerging during infrastructural changes. The issue order view implies that it is not sufficient to simplistically list technical or user-related reasons to understand user resistance or “crisis” in the implementation and use of information technology. As the issue order model uses rich contextual data, it is a suitable conceptualising tool in a qualitative study.

Methodology in the hospital case

The qualitative data in the hospital case is composed of interview materials and various hospital documents that are related to the implementation of the EPR. The half-structured interviews were planned as relatively informal discussions between the users of the EPR and the first writer of this paper. Interviewing was chosen as the method of the data gathering, because it enables the gathering of data to understand local meanings and to explore the change process from new viewpoints (Lofland and Lofland 1995). In this case, the study subjects were chosen amongst the members of the surgical clinic according to their own and the project administration’s recommendations. The staff of the other unit stated that they weren’t using the EPR in November 2005 when the problem situation emerged in

the surgical clinic. In whole, ten of the interview subjects were members of the two surgical units and three were members of the EPR project. The interviews were carried out during spring and summer 2006. They were audio taped and later transcribed.

Besides the interviews there was a video recording of an actual use situation of the EPR in clinical work in the surgical clinic. The recording was made to inspect and find solutions to the problematic situation during February 2006. The document shows both manual and electronic recording of patient data, and a situation where a surgeon and a nurse worked with one of the in-bed patients.

Background information was also gathered by scrutinizing previous studies in the same university hospital. The previous studies include materials from interviews and observations, and academic writings. Several related hospital documents were also reviewed for an overall picture of the situation.

Data gathering was carried out using qualitative methods (e.g. Lofland and Lofland, 1995). The validity of qualitative research is improved by using several methods for gathering data and by ensuring that the data is relevant to the research questions (Altheide and Johnson 1994; Lofland and Lofland 1995). Altheide and Johnson (1994, p. 488) describe the validity of qualitative research as depending on the interpretative communities – the audiences – as well as on the goals of the research: “All knowledge and claims to knowledge are reflexive of the process, assumptions, location, history, and context of knowing and the knower.” As such, the results of this study cannot be used, for example, to generalize best practices for using an EPR. Instead they provide a description of some possible situations and may be used in deepening the understanding of issues associated with the EPR use.

The data analysis was conducted in the following way (See Figure 1). First, all of the collected data was arranged according to themes relating to the research questions. Second, within these themes, we started to arrange recurrent issues according to the issues orders in Star’s and Ruhleder’s (1996) model. We noted that the same issues could be placed on different issue order levels depending on the perspective of the informant. A single issue could also be seen to have different consequences if looked at from the perspective of different contexts, which also supported our decision to position some issues on multiple levels.

Third, after the issue order analysis the results are to be reflected on social structures (Giddens, 1979, 1984) that affect hospital working. This includes, for example, exploring what kind of meanings the surgical units’ staff gave to the EPR, and how these interpretations were signified within the organization or transmitted through communication. Also, what were the norms that guided the staff members in their technology use, or how the use was legitimized in the organization, or were there sanctions implemented in cases of non-use. Social structure analysis includes also power issues that are apparent in any implementation and affect everyday working.

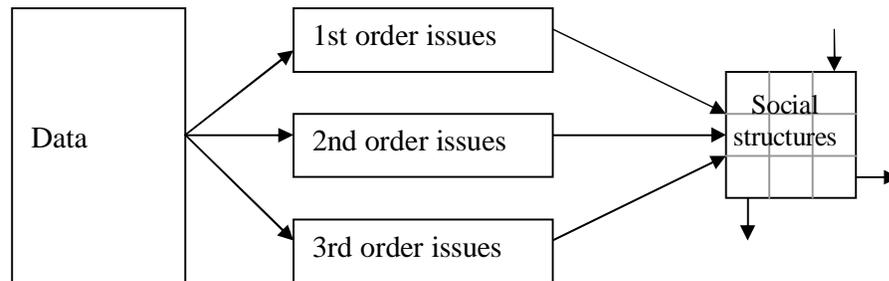


Figure 1. Data analysis phases.

During the case study, our main interests were in the analysis of the user experiences by the personnel in the surgical clinic. We attempted to analyse how information system use was interpreted in various daily working situations and what kind of meanings were given to different features of use, or how problems were connected with use. We attempted to give voice to different interest groups as they studied the problems from various viewpoints and as the problem situation affected their working in multiple ways.

Preliminary findings

First order issues were common and easily visible in the hospital case. First order issues were grouped according to the themes of redistribution of work resources and working time, arranging user training, and in relation to technical problems during the implementation. For example, during the manual recording of patient information there were often gaps in the surgeons' dictations about their patients. Often the dictations existed on tapes, but the surgeons didn't know how to access this information. Dictations were accessible only after the ward secretaries had typed the dictations and printed them on paper.

After the implementation of the EPR, a similar problem in information access was caused by slowness of use. It was slower to use electronic records in comparison to using paper records at hand. One of the system features that increases slowness is the structured character of the EPR. For example, there are over 50 headings for recording a nursing action. One of the nurses describes the situation as follows:

"Now I have to open Miranda [EPR], to open the nursing records. Now I'll make the record, that takes many clicks – like surgeons name, date, and cause this and cause that. Then I'll have to choose the right headings, and then I can go and record the day visit by the patient, I can make it, and then I'll have to choose the next suitable heading... I have many phases here, phases that I have never done before... Before I just wrote, for example, 'covering letter' and 'breast cancer' on the paper and that was it." (Nurse02)

The slowness of use affects the working in various ways. For example, in the surgical out-patient department with continuous patient visits, half of the working time consists of making patient records. In contrast, this took only about 1/8 of the working time in the surgical ward. In this view, it is understandable that the slowness of use can cause problems for daily work. This can cause the staff to think twice whether to use paper records or electronic records as they weight the pros and cons of the EPR use - especially in situations where a patient has an acute need. For example, in the surgical clinic it was the nurses who decided that they will not use the EPR, whereas in the ward it was the doctors, who didn't want to use the EPR. This caused a situation where some of the patient records were on paper and some in electronic form. Furthermore, in relation to the slowness of use, general usability of the EPR is not very good if we consider the need to "click" many times, the problems with scanning the records, or getting some understanding of a patient's current situation at one glance, without having to check several views.

Second order issues are caused by the combined effects of several first order problems or by cultural differences. Combined effects of technical features that caused user resistance, are, for example, the way the EPR logs off users, how the technical artefacts are arranged in the wards, or other kind of problems which are caused by the constant need to re-logout to the system. Constant technical problems caused the users to feel that the EPR does not ease their documenting load so much but interferes with their working and causes un-needed periods of waiting, for example, for the system to open or to find the next patient's data. Technical problems are illustrated also by the varied practices during breakdowns of the EPR use. During such breakdowns patient records can be written as separate text files that can then be added in the EPR after the breakdown. Problems emerge when the separate text files are attached only as printouts to the paper version of the patient records and not in the EPR. This causes that the EPR is not necessarily up-to-date, and that the staff cannot trust the information in the EPR. The slowness of use can also be inspected as a second order issue when it is related to problems of resource allocation. One surgeon isn't necessarily able to carry out multiple tasks at a time, but instead she or he has to prioritize. And when tasks are prioritized, caring for the patients wins over documenting the care:

"...during weekends – it can be that one surgeon is responsible for the whole ward, and he or she can also be the one on duty for the operating room at the same time. That is quite an impossible situation." (Nurse 10)

The second order issues are also related to the working time allocation, such as, how nurses' working time is divided between nursing in the surgical clinic and, for example, participating in user training. The user training has been arranged within different wards in a manner that the key users are responsible for training the other users. This decreases the number of nurses working in the wards and increases nursing tasks for those who are not attending the training. This can cause the

nurses to think of the consequences for their co-workers if they themselves are attending user training session. The nurses can also weight what are necessary workplace training sessions that they will participate in. In practice, this causes a situation where the use of the EPR is learned step by step in the actual nursing work. Further problems are caused by the cultural differences between different organizational units that can be inspected in the ways the use varies and how the EPR has been modified to local needs.

Third order issues are related to the issues behind the implementation project and its goals, the technical choices made during the implementation, the status of different tasks, the motivation of personnel, and in finding meaningfulness in ones own work. System users in the surgical clinic felt that they had no influence in the system design and development. They felt that the EPR was developed according to the needs of larger hospital units or ward nurses. The surgeons felt also that the slowness in EPR can cause multiple third order problems. For example, while working bedside both a surgeon and a nurse may record information quite fluently and not consider whose user account was used to log in the system. Problems of responsibility emerge when mistakes are made in the records. The one whose username was used is held responsible. On the other hand, surgeons fear that the slowness of use can cause malpractice in situations when patient information cannot be accessed as easily as needed. A surgeon may have to make a decision concerning the patient care with insufficient information.

Problems are caused by the division of work tasks, which has changed somewhat after the implementation. Division of tasks can also be different between units, and this causes the personnel to ask repeatedly: Whose responsibility is this particular task? The answer is often dependent on the person who gives the answer. For example, a surgeon, a nurse or a project leader can all give different answers. One of the third order problems is also how the nurses interpret meanings behind the new record keeping. Most nurses state that EPR does not help their work and that instead the records are kept for some third party. Hospital administration, researchers, the national health record project, and other nursing representatives are named as representatives for such third party:

“...it can be a little easier to find new information in EPR, where they are structurally arranged, than if we still would have the paper story... But in practical nursing it is often hard to understand why we do it in such a difficult way just because someone else wants to make statistics or research.” (Nurse01)

Our case study showed two examples of a situation that could lead to double binds. The first was the tension caused by the expected mandatory use of EPR and the breakdowns and information gaps in the EPR. And the second was the clinic personnel feel that they are expected to use a system, which information content they cannot fully trust upon.

Discussion and the future of the hospital case study

The hospital case study is still in progress, and the analysis of crisis in the surgical clinic is not yet complete. This paper aims to describe some preliminary results of the issues and problems encountered when the EPR was implemented. The conflicting or crisis situation was caused by a situation that consisted of multiple and intertwined socio-technical issues. Emergence of such issues demanded attention on several levels in the organization. In this case, for example, information management department and hospital administration representatives were also needed. The preliminary results suggest that social structures affecting the interaction in a hospital unit are partly a cause for the emergence of intertwined problems, handling the issues and resolving the crisis.

Working in a hospital means that the workers' actions are regulated by multiple rules, standards, and hospital guidelines besides the knowledge and tacit skills that the staff members have acquired through working. Social structures (Giddens, 1979, 1984) such as rules and norms guide the working of both nurses and surgeons or other doctors. An example of social structures can be observed embedded in daily nursing routines for example in a situation where nurses interpret new information technology in patient care and in documenting the nursing action. With manual patient records, nurses were used to interpreting the paper records. Now, with the new electronic record keeping the feelings of insecurity emerged as well as the fear of ignorance as the previously usable interpretive schemes were insufficient in the changing context of interpretation. With the EPR, the patient information was "hidden" behind different headings of new nursing classifications and behind the views in the new system environment (Zuboff, 1988). Furthermore, the EPR has been designed as independent system components. These components can work quite well by themselves, but integration has caused some unexpected effects which have been problematic for the users. Uncertainty combined with technical problems caused user resistance to reach its peak, and thus the crisis emerged.

Another possible explanation for the user resistance is that the new EPR users interpreted the implemented technology as something extra, something that does not support their working tasks in a sufficient manner (cf. Jones, 2003). In this case, especially the nurses felt that the EPR was implemented to help the working of some third party such as the hospital management or possible researchers.

To sum up the study so far, we return to the main research question: What is the role of the information system in the emerging problems? The hospital case indicates that technical problems, such as slowness of use, can cause user resistance or at least increase users' doubt towards the new information system. On the other hand, issues concerning professional values, such as fear of malpractice due to missing or un-accessible patient information, can cause a decision not to use the system at all. Noteworthy is that the reason for resistance

of non-use is not purely technical or social issue but a combination of socio-technical issues that are affected by the history of the organizational development.

To combine the issue order analysis systematically with the conceptualization of social structures remains still as a future challenge for this case study. It also remains to be seen, whether we can identify particular features of hospital environment that affect the emerging of these kind of problem situations. The problem situations could be handled towards a satisfactory solution more efficiently, if the situations could be noted more early on, and if the problems could be negotiated by all relevant stakeholders together. This would need the culture of practice in the given hospital to be developed further or at least the users to have recovered from previous information technology implementation and use crisis.

Acknowledgments

We want to thank all the interviewees who gave their valuable time for the interviews.

References

- Altheide, D.L., and J.M. Johnson (1994), Criteria for Assessing Interpretive Validity in Qualitative Research, in: Denzin N.K., and Y.S. Lincoln (eds.) *Handbook of Qualitative Research*. Sage, 485-499.
- Barrett, M., and G. Walsham. (2004). Making Contributions from Interpretive Case Studies: Examining Process of Construction and Use, in: Kaplan, B., D.P. Truex III, D. Wastell, A.T. Wood-Harper, and J.I. DeGross (eds.) *Information Systems Research: Relevant Theory and Informed Practice*. Kluwer, Boston, 293-312.
- Bateson, G. (1978). *Steps to an Ecology of Mind*. Ballantine Books, New York.
- Berg, M., C. Langenberg, I. v.d. Berg, and J. Kwakkernaat. (1998). Considerations for sociotechnical design: experiences with an electronic patient record in a clinical context, *International Journal of Medical Informatics* 52, 243–251.
- Berg, M. (1999). Patient care information systems and health care work: a socio-technical approach, *International Journal of Medical Informatics* 55, 87–101.
- Berg, M. (2001). Implementing information systems in health care organization: myths and challenges, *International Journal of Medical Informatics* 64, 143-153.
- Berg, M. (2004). *Health Information Management: Integrating information technology in health care work*. London, Routledge.
- Bishop, A.P., L.J. Neumann, S.L. Star, C. Merkel, E. Ignacio, and R.J. Sandusky. (2000). Digital Libraries: Situating Use in Changing Information Infrastructure. *Journal of the American Society for Information Science* 51(4), 394-413.
- Giddens, A. (1979). *Central problems in social theory: Action, structure and contradiction in social analysis*. London, Macmillan.
- Giddens, A. (1984). *The Constitution of Society*. Polity Press, Cambridge.
- Hougham, M. (1996). London Ambulance Service computer-aided despatch system. *International Journal of Project Management* 14(2), 103-110.

- Jones, M., W.J. Orlikowski and K. Munir. (2004). Structuration Theory and Information Systems: A Critical Reappraisal, in Mingers, J., and L. Willcocks (eds.) *Social Theory and Philosophy for Information Systems*. John Wiley & Sons, Ltd, Chichester, 297-328.
- Jones, M., and H. Karsten. (2003). *Structuration Theory and Information Systems Research*. Working paper, Judge Institute of Management, University of Cambridge.
- Jones, M. (2003). Computers can land people on Mars, why can't they get them to work in a hospital? Implementation of an Electronic Patient Record System in a UK hospital, *Methods of Information in Medicine* 42(4), 410-415.
- Karsten, H., and Laine, A. (2006). User interpretations of future information system use: a snapshot with technological frames, *International Journal of Medical Informatics*, Jun 22.
- Lamb, R., and S. Sawyer. (2005). On extending social informatics from a rich legacy of networks and conceptual resources, *Information Technology & People* 18(1), 9-20.
- Latour, B. (1987). *Science in Action*. Open University Press, Milton Keynes.
- Markus, M.L. (1983). Power, Politics and MIS Implementation, *Communications of the ACM*, 26 (6), 430-444.
- Nonaka, I., and Takeuchi, H. (1995). *The Knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford University Press, New York.
- Lofland, J., and L. Lofland. (1995). *Analyzing Social Settings. A Guide to Qualitative Observation and Analysis*. Wadsworth Publishing Company, Belmont.
- Orlikowski, W.J. (1992). The Duality of Technology: Rethinking the concept of technology in organizations. *Organization Science* 3(3), 398-428.
- Orlikowski, W.J. (1996). Improvising Organizational Transformation over Time: A Situated Change Perspective. *Information Systems Research* 7(1), 63-92.
- Orlikowski, W.J., and D.C. Gash. (1994). Technological Frames: Making Sense of Information Technology in Organizations, *ACM Transactions on Information Systems*, 12(2), 174-207.
- Oxford English Dictionary Online*. Retrieved May 24, 2007, from <http://www.oed.com/>
- Sahay, S., and D. Robey. (1996). Organizational context, social interpretation, and the implementation and consequences of geographic information systems, *Accounting, Management and Information Technologies*, 6 (4), 255-282.
- Scott, J.T., T.G. Rundall, T.M. Vogt, and J. Hsu. (2005). Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study, *British Medical Journal* 331, 1313-1316.
- Star, S.L., and K. Ruhleder. (1996). Steps towards an ecology of infrastructure: Design and access for large information spaces, *Information Systems Research*, 7. 111-135.
- Woolgar, S. (1991). Configuring the user: the case of usability trials, in Law, J. (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination*. Routledge, London, 57-101.
- Zuboff, S. (1988). *In the Age of the Smart Machine*. Basic Books, London.

Deconstruction of Medication Related Services And Reconstructing The Management of Personal Health Information

Pekka Muukkonen and Markku I. Nurminen

University of Turku, Department of Information Technology, LABORIS

pekka.muukkonen@utu.fi, markku.nurminen@utu.fi

Abstract. There has begun to emerge an expanding body of literature that emphasizes the role of an individual citizen in the management of health information. In this paper we analyze some implications of this tendency in relation to medical services. The analysis is based on the deconstruction of relationships in health industry that constitutes of healthcare providers, pharmacies, insurance companies, medical suppliers, citizens *et cetera*. We illustrate the structure of the services as two-party relationships, from which we identify distinct information needs for each stakeholder. The structural analysis gives an opportunity to pinpoint possibilities for better utilization of information technology that enhances the service level along with information integrity and personal privacy from the viewpoint of a citizen in the form of a Personal Health Record as an e-Health Diary.

Keywords. Consumer Health Informatics, medication services, service relationships, deconstruction, personal health information, e-health diary, empowerment.

Introduction

An increasing number of research articles bring to focus the role of an individual citizen in the management of health information (e.g. Altinkemer et al., 2006; Pratt et al., 2006; Lafky et al. 2006; de Clercq et al. 2003). The emphasis and

level of discussion vary from paper to another. For example Altinkemper et al. (2006) envision the future of e-services in health industry and the role of an individual from a general perspective, while de Clercq et al. (2003) and Gustafson et al. (2002) have their point of departure in more detailed case examples. A common denominator found in all above mentioned papers is the renewal of health services with the help of information and communication technology so that an individual could perform more actively in promoting one's health.

This paper focuses on the organizing structure of medication services as a part of medical services. The essential aim is to identify and explain the changes in service relationships if the citizen was put forth in a more prominent position as an active participant in information management. In doing so, we examine the discipline of Consumer Health Informatics (CHI) as one possible point of departure to envisage e-services in the healthcare sector.

The remaining structure of this paper comprises of five sections. In section 2 we frame one possible background for development directions of e-Health services by introducing some ideas found in CHI. In the following section we explore and analyze the existing body of literature that discusses the management of personal health information. Section 4 introduces our research method of 'deconstruction', upon which we build our analysis of the structure of relationships and information needs in services dealing with medication management. A discussion about the consequences of citizen oriented health information system is done in section 5, while section 6 summarises our findings and completes the paper.

Consumer Health Informatics as foundations for personal health information management

One recently established discipline that integrates research interests of informatics and healthcare is the Consumer Health Informatics, abbreviated as CHI (Lewis et al., 2005; Eysenbach & Jadad, 2001; Jones, 2000; Gustafson et al., 2002). The governing principle of CHI is to involve receivers of care actively into participation in health promotion. CHI challenges the prevailing "paternalistic model of health care" and proposes "moves towards greater informed choice for consumer in their health care decisions" (Eysenbach & Jadad, 2001). The motive for striving CHI is in helping patients to "—make decisions about health treatment, to adjust themselves psychologically, and to feel more in control of their situation" (Jones, 2000). The ideal of CHI was formulated by Eysenbach & Jadad (2001) in a following statement:

"Ideally (as long as they wish), all consumers should be able to access valid and relevant information about their health status. They should be able to judge the advantages and disadvantages of all possible courses of action, according to their values, beliefs,

preferences, and their personal circumstances (for example, their socio-economic status).”

The issue of giving consumers an access to their (electronic) health records seems to be a complicated one in political, social and technical sense (e.g. Carter, 1998). In politics this issue has been acknowledged and the results include among others The European Union Data Directive made effective in 1998 (Directive 95/46/EC), Health Insurance Portability and Accountability Act of 1996 in the USA (HIPAA) and Personal Information Protection and Electronic Documents Act of 2000 in Canada (PIPEDA). In spite of the legal ground that has been built, consumer oriented or even consumer managed health related information services have remained a scarce resource - we still lack widely spread concrete technologies and information systems that would allow consumers to be more active participants in their health-related relationships. The problem is not solely political, but to a great extent many social issues interfere with the development of empowering technology in the health industry. One of the most prominent aspect is still quite common authoritarian and patronizing approach of medical practitioners towards their patients – a situation that has even lead some to say that the modern establishment of medical industry has caused an “expropriation of health” by withholding relevant information from the patients that leads to the disability to make informed choices (Illich, 1975). Even if Illich's statement might be viewed as a bit exaggerated, controversial and even outdated, the argument causes a strange resembling reminiscent of some personal experiences of the authors. The technical part of accessing or even collecting the personal health records in a digital form is caused by the unbalanced situation where the other party has an information system where the other – the consumer – has not been provided by a comparably strong tool to form an equal relationship what comes to the information management.

Although some systems have already been built according to the principles of CHI, they have had a rather narrow focus as will be discussed in section 3. In this paper we wish to examine the plausibility of CHI approach in building sustainable healthcare services in a larger scale. We focus our attention in medication services, for it is seems to one of the most visible and topical issues in today's health industry. Questions which are to be resolved include the following:

- What kind of service architecture exists in delivering medication services?
- What are the relevant stakeholders that need to be addressed?
- What are the information needs for different stakeholders?
- How the CHI-ideal would affect the relationships between the stakeholders?
- What are the consequences for the citizen?

Previous work on CHI

Early patient-centered information systems have been implemented to aid the management of some particular diseases or illnesses, for example diabetes (de Clercq et al., 2003) and cancer (Gustafson et al., 2002). Besides managing diseases, other intention to use these kinds of systems has been in providing information that gives advice in activities that try to prevent diseases from erupting – an example in the periodontal sector e.g. Ojima et al. 2003.

These systems have provided consumers an access to information services that enable them better to identify health risks and a need for treatment, get laboratory results, receive online consultation, locate service providers and reserve appointments. Some of these systems have also provided a function to serve as care reminders – to remind to do some activities that promote one's health, be they either preventive or rehabilitative by nature.

While systems of this kind have given real help to many patients and their care providers, they have caused them a misservice by fragmenting the overview of the patient's health situation, in particular when multiple channels of communication have been used. Different units of primary, secondary and tertiary health care¹ still have proprietary systems of their own. The access problem to exhaustive information of an actual illness still seems to wait for its solution. Also other diseases or illnesses are likely to remain unrelated, so it is hard or even impossible to get an overall picture of individual's health situation as a whole.

Another problem in patient-centered information systems is the number of different stakeholders. As there may be several units that provide care for one person, there are also pharmacies that supply medicines. Yet another group of stakeholders is the set of various financing institutions that vary from one country to another. One patient – or citizen – has to maintain relationships to all these stakeholders. This creates a plethora of intertwined and entangled transactions that need to be managed. The “spaghetti” created by the number of different stakeholders and their mutual dependencies creates also different kinds of problems of privacy protection and authentication.

The spaghetti problem has not remained unobserved. For example, Altinkemer et al. (2006) have described a rather comprehensive layout of the health industry and named it as a “consumer 2 healthcare provider marketplace” (C2H). This “marketplace” conception adds elements like insurance companies, hospitals, pharmacies and medical suppliers as stakeholders in information provision and utilization (figure 1).

¹ We refer to the definitions of *European Observatory on Health Systems and Policies*. <http://www.euro.who.int/observatory/Glossary/TopPage>

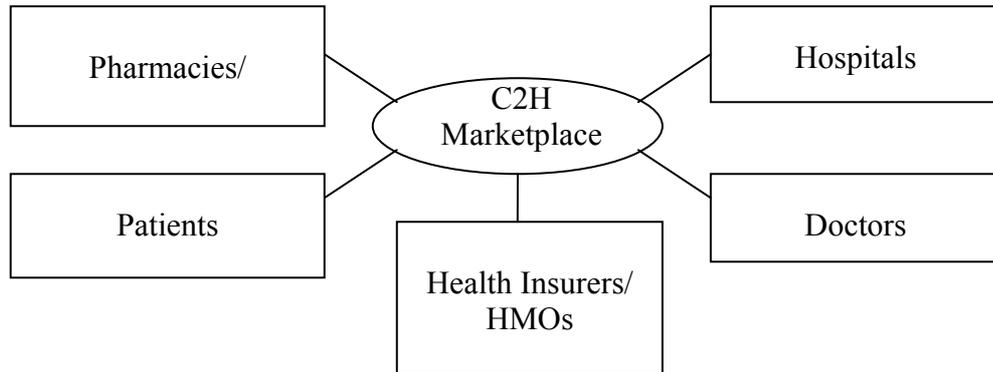


Figure 1. The C2H Marketplace (Altinkemer et. al., 2006).

The vision of the C2H marketplace is based on an integrated system model. A few remarks on it have to be made:

- Like many stakeholder-based models, the C2H marketplace assumes an apparently equal role to each stakeholder. Yet each of them has its own specialized role and consequently unequal weight and power in relation to other stakeholders. Because the C2H marketplace does not specifically define the role descriptions for different parties or analyze what kind of relationships they have, we lack a clear view of the service structure. We cannot for example distinguish services, in which the patient is directly involved and services that could be referred as "back-office"-services.
- As a marketplace model, C2H offers services to the stakeholders. However, this model fails to underscore the primary role of services that are practicable only in direct person-to-person encounters by obscuring the relation dependencies. With this model we cannot clearly define the distinct needs and uses for health information for each pair of stakeholders in their mutual services.
- The market orientation obscures the idea of patient-centeredness. Patient-centeredness was chosen as one of the main premises for this paper. It is a strong tool in identifying and preventing many ethically challenging situations, as for example in providing a perspective to situations like what happened in Iceland when they granted an access to the health records of a whole population to a third party (Andersen, 1998).

Furthermore, from this kind of market metaphor and "spaghetti structure" for health industry it is difficult to analyze in detail the "processes" and activities of the patient - or any of the other mentioned parties. We need greater analytical power and emphasis in the core services where the citizen is seen as the primary customer. The conceptual framework should put the citizen in the focus as is done in a model developed by Pratt et al. (2006) that emphasizes the role of the patient as an active actor in the management of (personal) health information (figure 2).

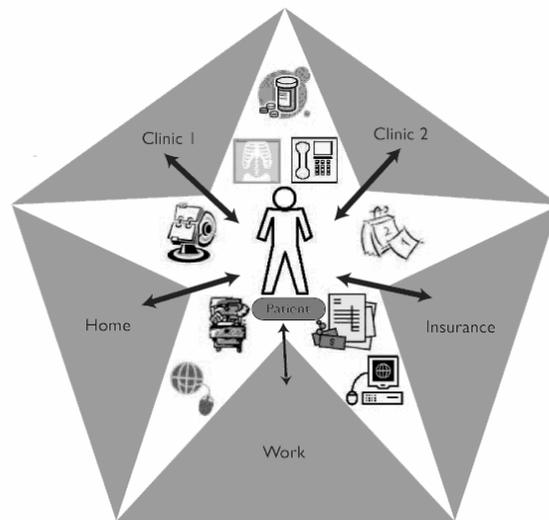


Figure 2. Patient-centered health information management layout (Pratt et al., 2006)

We adopt the basic idea of the vision of Pratt et al. (ibid.) and build our deconstruction of the health industry to elaborate this model further. In the next section we deconstruct the service relationships between the primary units of health industry in medication services.

Deconstruction of medication related services

Deconstruction is a concept put forth by the late Jacques Derrida. According to Orlikowski & Beath (1994) deconstruction has been used as a tool in "*—taking things apart, whether they be philosophical arguments, literary texts, historical narratives, conventions, canons, or value systems of any kind.*". Deconstruction is an analytic strategy, which tries to see beyond the superstructure of cultural artefacts and reveal the form and content, possible contradictions, implicit meanings and unacknowledged biases (Orlikowski & Beath, ibid.). As such, we apply a lightweight version of this technique of deconstruction to set our sight in the 'form and content' of the cultural artefact termed health industry. From this analysis we identify the existing conventions in organising medication services and their electronic equivalences.

The premise upon which we shall compare our results of this investigation is that the *purpose* of the health industry is in the promotion of health of an individual (that can be aggregated to concern the health of a population). We think that this is an uncompromised criterion. To begin our deconstruction, we shall decipher the elements that we call *division of labour* and *division of information*.

Primary relationships

The first element we need is the subject of healthcare – the citizen. We decided to use this term in this paper instead of "consumer", "customer", "client", "case of illness", "patient" or such, just to remind ourselves that we are dealing with actual individual persons who possess rights and responsibilities within this cultural collective. Our focus is on the elementary relationships, in which the citizen is in direct encounter with other stakeholders. The first element we need in addition to the citizen is healthcare providers. By this element we refer to different clinicians, physicians and nurses – whether they operate in the units of primary healthcare, secondary healthcare or tertiary healthcare either in the public or the private sector (figure 3).

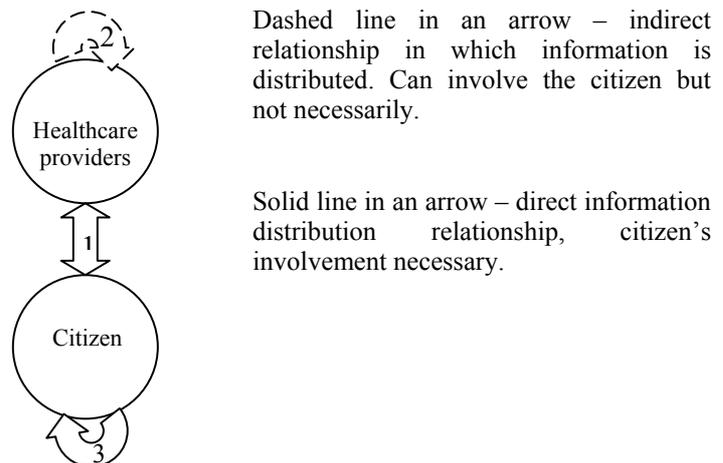


Figure 3. The basic service relationship in the health industry

In this basic relationship the *division of labour* refers to the division of health custodianship. A partial custody of citizen's health is appropriated by the healthcare provider. To be able to perform the role of the custodian in a proficient manner and adopt the following responsibility, one has to possess some kind of general view of the object of custody. This general view can be generated based on information received from two sources. Primary source of information is the citizen (Fig. 3, arrow 1). The secondary source is the possibly existing health record(s) that is in possession of the healthcare provider (Fig. 3, arrow 2). Information needs for the healthcare provider can be generalized to refer *history of performed operations, allergies, immunizations, chronic diseases, history and current state of used medication, test results and current plans for medical or*

physical treatment. This information is needed in order to decide best treatments and possible medication. In the case of medication, the information concerning usage history and the current use is of crucial importance. Medication information is needed to avoid unsuitable substances or avert drug interactions.

Information that should be recorded in this primary service situation are the entries of given treatment, performed tests and their results, pharmaceuticals given and in some cases a new or altered health promotion plan. As a part of this plan there may be instructions for performing some activities, e.g. taking pills or monitoring sugar level, blood pressure, heart rate and the like.

The users of produced information are both parties. For the citizen the purpose of this information is quite evident. Information should provide an explicit instruction for treating her condition and act as a description of care given. Usually this information has been delivered to the citizen either orally or inscribed in paper. The citizen can refresh one's memory every once in a while about the instructions and perform some self-monitoring activities that raise the awareness of the citizen (Fig 3, arrow 3). For the healthcare provider produced information acts primarily as a status description of the citizen that can be utilized in future diagnoses. Secondly the information can be regarded as a legal document which can be referred to if prosecuted of mistreatment. But the information has also other uses beyond a single encounter. Since the citizen is not restricted to receive care only from one source, but in many cases there is a multitude of care providers attending to citizen's situation over time, collected information can act as a bridge between providers in spreading the status information of the citizen. The question is: how the information distribution has been arranged?

Traditionally information produced in this relationship has been stored in local databases that are maintained by the sole service providers. If there has been a need to transfer information between different service providers, the citizen has acted in the role of message carrier (arrow 2). However, when information technology has been utilized to take the role of "message carrier", there has emerged a need to harmonize the different data formats and transfer protocols of distinct systems. Another option has been the establishment of a new integrated service-platform. Many electronic health record (EHR) initiatives have been focused in this recursive relationship between different healthcare providers. However, as the producers of information increase in number, it becomes unclear who is the actual proprietor of the health information in this shared model of information production. This emerging practice gives a new set of problems to consider what comes to the accessibility that could compromise confidentiality and personal privacy.

Part of the information stored in the health record is concerned with medication information. For this part we use a term "medication record". Medication record contains the prescribed medicines appointed by a licensed

doctor. Some medicine can be given by the healthcare provider in the primary relationship, but as the distribution of pharmaceuticals in a larger scale has become “outsourced” from the processes of healthcare providers and become a regulated and controlled activity that require a special licence, the division of labour between prescribing medicine and providing it is split between the roles of diagnostician and a pharmacist. Thus the role of a pharmacist is added to this illustration (figure 4).

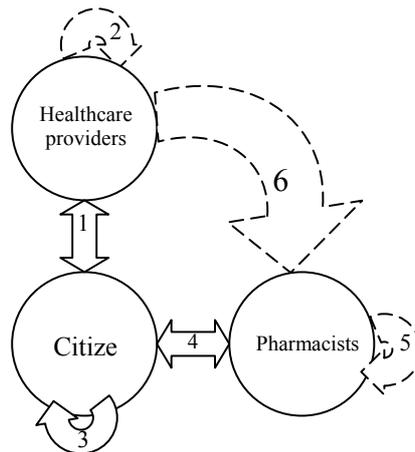


Figure 4. Three party relationship of the Health Industry

Citizen’s role between the healthcare provider and the pharmacist has initially been a mediator of prescription information (arrow 4). Information needs for a pharmacist to provide his primary service, the delivery of medicine, are quite simple. A pharmacist needs to validate citizen’s identification information, doctor’s identification information, name of the prescribed drug and the dosage. In some cases there is possibly some additional information, for example the amount of drugs that can be delivered in one purchase occasion.

The information that is produced in this service situation concerns naturally the purchased drugs. On the one hand this is required because the pharmacy is usually obligated to report their sales to some supervisory instance. However, the sales information helps also a pharmacy to establish a local customer register and provide some extra service based on that, e.g. checking that the purchased drugs do not cause interactions with existing medication (arrow 5 in fig 4). This is usually possible only when the citizen has signed in to some kind of ‘loyal customer’-relationship or is prepared to pay for this kind of service. It could be argued that knowledge about the possible interactions should be a basic right of the citizen to attain in all cases - not only through a payable service or as a part of some loyal customer programme, but so far this has not become the customary procedure. The information citizen receives from this relationship is the dosage

and perhaps some cautionary piece of advice for the use (Fig. 4, arrow 4). This information can also be needed to be reflected upon and refreshed in some occasions, so the recursive relationship of the citizen is given more weight (arrow 3). Some e-service endeavours have been initiated in regard to this service relationship.

The most prominent e-service in this constellation is the electronic prescribing that removes the burden of prescription carrying from the citizen by establishing a direct link between the healthcare provider and a pharmacy (Fig. 4, arrow 6). The information about the purchased medicine would also be an interest of the healthcare provider who prescribed the drug if s/he would like to expand the role of the custodian even further – into the direction of surveillance. This could also be realized via e-prescription database, if a notification was sent to the doctor when the medicine has been purchased. However, there are some legislative barriers to this kind of action and in many cases a consent it is required from the citizen. This structural arrangement of information handling leaves also the proprietary issue under question – is the proprietor of medical records now the healthcare provider(s), pharmacists, citizen or some other instance? Another party to whom the information about purchased medicine is of importance is the possible instance that takes part in the expenses. This role is usually adopted by an insurer - whether the insurance is provided by some national arrangement, by employer or by some private policy (figure 5).

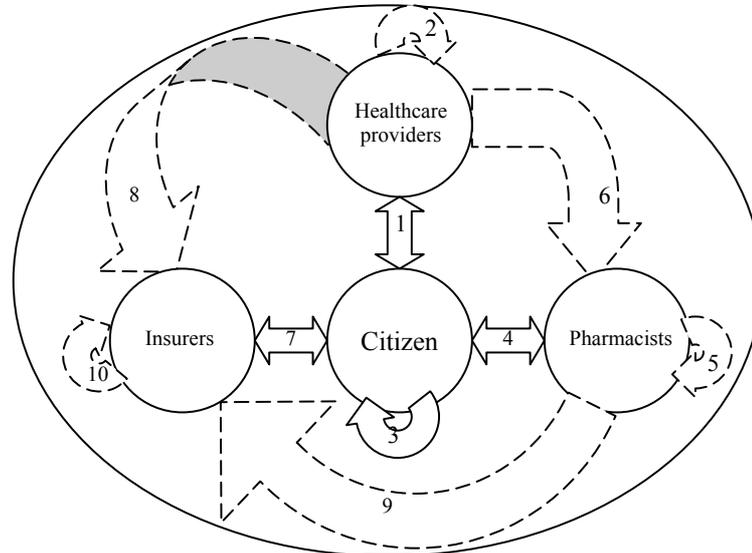


Figure 5. The quartet structure of medication information stakeholders – The domain for COHIS

The role of the citizen between a pharmacist and an insurance company is once again the role of a message carrier (Fig. 5, arrow 7). Information needs for the insurer is the amount of purchased drugs, their cost and the condition for which these drugs had to be acquired. The last information is actually created by the healthcare provider, so there is a link between healthcare provider and the insurer

that we left unmentioned in figure 3, now explicated in figure 5 as an arrow number 8. The pharmacy needs information to direct the payment to a proper party via relationships 7 and 4 – in short these are the insurer's name and citizen's policy number. In case there are multiple insurance parties involved, some kind of coordinative action is needed in order to validate the proper payment fractions (arrow 10). In many cases this coordination task falls to the citizen to perform when the complexes accumulate.

The information link between the pharmacist and insurer could also be made to operate as an electronic service that bypasses the citizen (Fig 5, arrow 9). This could also be operationalized via the e-prescription database, as the insurer could access the information that pharmacist has entered to the system directly. It would seem that most of the information carrier roles performed by the citizen could be made an obsolete way of organizing information distribution between different stakeholders. A database integrating the processes of different parties and satisfying the information needs for all could be established, for example as a nation wide central archive of EHR's and prescription records. However, one has to bear in mind that one crucial information need cannot be left unattended in aspirations towards centralized modes of service-platforms. The citizen is the main actor in this endeavour and supposedly acts as the primary custodian of one's health and the manager of one's affairs. The ability to perform as an active and responsible actor requires that the actor is given the possibility to appropriate relevant information and complement it if necessary. This is the recursive information loop of the citizen (fig 5, arrow 3).

The quartet of stakeholders in figure 5 and their entangled relationships represents in our opinion the basic service structure of medication part of the health industry. This quartet also describes the parties that should be served in possible citizen oriented health information systems (COHIS). One could argue that medical wholesalers, pharmaceutical companies, independent research institutes, supervision institutions and medical regulators among others belong also to the health industry (figure 6). This is true of course. The crucial point is that they are not usually in a direct service relationship with citizens *per se*. Because their services are in the "outer rim" and they are affiliated more with other parties than individual citizens, we regard them as subsidiary entities and thus their service relationships are not analyzed in our model.

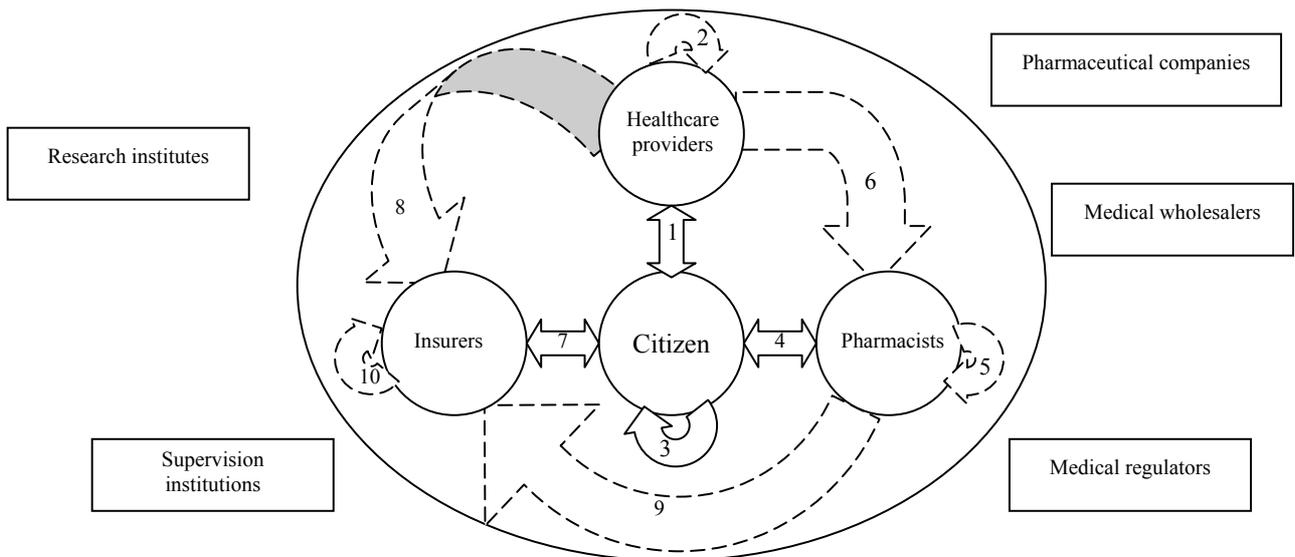


Figure 6. Health industry expanded beyond COHIS-model

The deconstruction of the health industry done from the angle of managing medication information helped us to identify more clearly the service structures and the derived information needs for different stakeholders. This deconstruction also aided to increase the granularity of the model of Pratt et al. (2006) presented in figure 2. The deconstruction provided us an insight that integrative e-service platforms, like centralized EHR-databases and e-prescription systems would leave us with an unclear image of the proprietor of medication information as a whole; also the systemic structures that would allow all relevant stakeholders to take an initiative in information production and utilization, including the citizen, remain ambiguous. It would also be important to identify the role that can be in control of these service processes and maintain an overall picture of the situation.

In the next section we discuss a proposition that grants the controlling role for managing medication information to the citizen. We illustrate our vision based on a distributed system structure, where an individual citizen is seen as a "self-maintaining"-node and discuss the benefits and disadvantages that would follow from this kind of structure.

Discussion – the e-Health Diary

In this section we utilize the deconstructed model of health industry and focus on the management of medication information from the viewpoint of the citizen. We try to describe an ideal process, in which some service interfaces built on the idea of COHIS-structure would be of benefit. We also try to see if some disadvantages would follow from this line of thought.

One of the most crucial issues around which new e-services could evolve is the electronic health record (EHR) of some kind (Tan, 2005). However, some of the current EHR initiatives are mainly designed only from the viewpoint of the healthcare providers. These system solutions are trying to ease the transfer of health information between several authority instances: information that is produced by them and used by them. These types of EHR-endeavours reflect a strange perversion in the information management if thought about from the COHIS perspective. If the initially inseparable subject of the information, citizen, disappears from the focus and is excluded from the designed processes, there is a possibility that new systems undermine the objective of helping the citizen to be in an active and responsible role and in charge of one's health situation. In relation to the management of medical records, we make a thought experiment, in which the proprietor of the information is the citizen him-/herself and see how the basic services could be constructed from this standpoint. However, we must first discuss the possible places where the information could be stored in a feasible manner for it to be accessible for all relevant stakeholders.

Management of a personal health record

Lafky et al. (2006) discuss the topic of personal health information in their recent paper. Their view is that this information should be collected to something called a personal health record (PHR). The key criteria they have set for the PHR is that

“—the record be longitudinal, ideally covering the entire lifespan; that the consumer has control over access to the information in the record; and that PHR must be distinct from the legal medical records that institutions are required to maintain.”

(Lafky et al., *ibid.*, p.1028-1029)

We agree to these criteria - with a reservation to the last issue. We think that the PHR should not be distinct in a way that it would contain *only* information that is not produced in “institutions”. We argue that it would serve all stakeholders in a best way, if a PHR would contain legal medical records *and* information produced by the citizen him-/herself.

In this scenario the keeping of medical records could be distributed between different stakeholders. The main possessor would be the citizen, but for example the healthcare providers and pharmacies could offer a sort of partial maintenance service in their local systems. The citizen would always have a possibility to have an access to one's records and receive a copy of them to a personal system setting. Of course, there should be some kind of digital signatures and encryptions to secure the data, so that these authority records could not be tampered with. As the proprietor of medical records, the citizen should have the possibility to take

into one's possession all concerned information and take it to another service provider if that would be the will. This kind of arrangement would give the citizen an ability to control the use of one's medical records. A concern for the coherence and up-to-dateness of data would not cause a substantial barrier, for if the citizen would always receive a personal copy of the updates made by different stakeholders, he could hand over the most recent data to other stakeholders either via a physical memory device or over a secure network – or ask the maintenance service to transfer the data for his behalf.

One argument to support this kind of arrangement is that the citizen should be enabled to add own records in addition to authority markings. These records could be markings of some important events, for example if some identified or unidentified symptoms occur, their date and duration could be marked down. This would give a support in articulating one's condition if a medical consultation should be needed. Also information about used over-the-counter drugs and herbal supplements could be added to the medication record in addition to prescription medicine to give a more complete picture of the overall medication. If preferred, some vital signs like heart rate, blood pressure and such could also be added to the personal health record on a regular basis. In this way the health information would be more complete and it could act as an "e-health diary" of the citizen. This diary could be stored to a secured memory device of some kind. As with other diaries, it would be up to the owner to decide who is allowed to read it. So what would be the benefits of this kind of "e-health diary"?

Implications for the service relationships

In the primary service relationship between the citizen and the healthcare provider, the e-health diary could provide all relevant information in an instant to the healthcare provider. The diary could be located in some sort of secured memory-stick that could be accessed in a physical meeting. Since the information would be in the possession of the citizen, some of the information could also be sent to the healthcare provider in advance before a meeting or for online consultation. The citizen could decide what information would be visible in certain service situations, so for example some delicate information could be delivered only in relationships that require a long-term treatment. From the "empowerment" perspective the diary gives the citizen an opportunity to ask for the best possible service, as the healthcare provider is given the most complete health representation of the citizen. This kind of arrangement would also serve the needs of the citizen better in "one shot" appointments, as for example in case of travel incidences. Also in these cases the attending healthcare provider could receive all relevant information – and the citizen would receive a copy of updated information when an appointment or a treatment period comes to an end. As the

diary would flow along the citizen from place to place between different service providers, there would not be a dependency upon any network-structure and possible breakdowns of it – although some networks, i.e. the Internet, could be utilized also as possible distribution channels in some cases.

In the case of citizen-pharmacy -relationship the e-health diary could also serve as a tool to get better service. If all prescribed and over-the-counter drugs were visible to the pharmacist via the diary, they could check for interaction side-effects and possibly recommend some additional substances to complement the medication or perhaps give an advice to trim the drug-palette in case of duplicate and overlapping medication. It would increase flexibility for the citizen in the “process of acquiring medicine” as he would not be tied to any particular pharmacy to receive these services, since information would not be needed to be stored in local regular-customer systems.

The relationship between citizen and the insurance company would also benefit from the existence of an e-health diary. All treatments and opinion statements recorded by healthcare providers along with all purchased prescription drugs recorded by pharmacists could be retrieved from the diary when needed. In case of applying for some insurance claims all relevant information could be found from the diary, so no substantial trouble would be needed in information gathering. The diary could also act in adjudicative role in claiming disability compensations, since all evidence would be available at once as a historical reference found from the diary.

However, the existence of this kind of diary would be most eligible to the citizen himself. With the help of e-health diary that could be carried along just like a credit card, citizen could claim all sorts of services to be performed better and more fluently within the health industry as described earlier. Citizen could also check the personal “health balance” when wanted. This would give a greater opportunity to make informed decisions, see the overall plan for the health promotion, perhaps identify some risk factors and take an initiative for preventive action. Within this personal system, some alerts could be programmed to remind of certain activities, e.g. taking medicine in time or making control visits to a doctor. Also the issue of mobility is worth mentioning. As citizens travel more, the probability to face a need for services of healthcare providers or pharmacists abroad increase. If a PHR that contains all relevant medical information would be available, it would ease the ability to receive adequate service in a pan-European and global setting. Also giving an account of prescribed medicine e.g. in customs could be more fluently handled. All in all, the existence of this kind of medical record in which the proprietor was the citizen would save a lot of trouble in sorting out access privileges and privacy concerns that would be a paramount issue to solve in centralized system structure solutions. This kind of structural arrangement would rather exhaustively help in protecting the legal rights of the citizen for personal privacy without a loss of information integrity.

The most prominent disadvantage compared to a centralized database that can be imagined is the occasion when the memory-device gets lost. The recovery of information would pose no significant problem, for a backup could be retrieved rather easily if information was stored also in one's personal computer. If the citizen did not own a personal computer, the information could be retrieved from the service providers who were permitted to have a copy of the PHR. Other issue is that the personal data could be hacked from the memory device if stolen. That is mainly a technical issue, which could be solved by applying some strong identification method e.g. a biometric identification and a PIN combination. And of course, you wouldn't need to carry around all the information all the time – you would have the control over what was written in the travel diary and would remain at home.

In this paper our deconstruction concentrated on the management of medication information. Even though this approach was promising and helped us to identify the relevant parties and reveal different needs and uses for information in detail for each of the stakeholders, this was only a partial deconstruction of the personal health information management. The method of deconstruction could also be applied in analyzing other health related activities, which involve domains like work and home as described by Pratt et al. (2006). In this way we could examine more of the possible benefits from Citizen Initiated Record-keeping as such, a CIR-concept put forth by Nurminen (2005) in a broader context and evaluate its promises for greater emancipation and personal empowerment as a part of personal life management in a future e-society.

Conclusions

In this paper we analyzed the structure of the health industry and identified a domain where some citizen oriented health information systems could be applied in regard to management of medication information. The citizen was recognized as an inseparable subject in the process of health information production and utilization. A conceptual framing of an e-health diary was described and some consequences were discussed if this kind of distributed and self-managed system structure implementation would be established. The main benefits were seen to be apparent in citizen's processes in relation to the different service situations reassuring the plausibility of CHI point of view in constructing healthcare services.

The e-health diary was seen as an "empowerment tool", which would grant the bearer a greater autonomy in claiming better services from multiple service providers. The citizen would have a greater power in choosing the preferred healthcare provider, take all information to a new healthcare provider if the

provider was changed for a reason or another, attain a possibility for better services from pharmacies, have all health plans available at once in a private setting for monitoring purposes and helping to get an overview of one's situation, claim all the benefits from insurance companies that are appointed by law and agreements, raise the ability to act as a responsible partner in shared decision making processes and have the personal health record in mobile form when moving from place to place – even transnationally. Another issue that was found to be feasible in this kind of structural arrangement was the management of accessibility rights and protection of citizen's privacy.

However, some important considerations were left unattended. A closer inspection of the ecological validity and feasibility, i.e. the easiness to realize this kind of structural arrangement and needed cultural adjustments was not done. Also the economical validity and feasibility remained untouched, as we did not discuss in detail what kind of business opportunities could be established to support the formation of distributed information maintenance. In addition some juridical points in reference to privacy issues were not dealt in adequate depth. These issues should be treated more thoroughly in future research in order to have a more complete picture and imagine new solutions for e-health services in our way towards more profound e-society.

Acknowledgments

Authors would like to express their gratitude towards the Finnish Funding Agency for Technology and Innovation (TEKES), that has funded the research project "Management of Medication Information". We wish particularly acknowledge our closest research partners Turku Health Care Services and the Turku University Hospital, who have provided us an opportunity to gather invaluable insights. Also the The Social Insurance Institution of Finland has been a great help and an open source for the research material in relation to the national e-prescription plans in Finland.

References

- Altinkemer, K., P. De, Z. D. Ozdemir (2006). "Information Systems and Health Care XII: Toward a Consumer-to-Healthcare Provider (C2H) Electronic Marketplace", *Communications of the Association for Information Systems*, vol. 18, 413-430.
- Andersen, B. (1998). "Icelandic Health Records", *Science*, vol. 282, no. 11, p.1991. Accessed via Internet 02.11.2006 <http://www.sciencemag.org/cgi/content/full/282/5396/1991e>
- Carter, Meredith (1998). "Should patients have access to their medical records?", *Medical Journal of Australia*, vol. 169, 596-597. Accessed 1.11.2006 via eMJA <http://www.mja.com.au/public/issues/xmas98/carter/carter.html>
- de Clercq, P. A., Hasman A. and Wolffenbuttel B. (2003). "A consumer health record for supporting the patient-centered management of chronic diseases", *Medical Informatics & The Internet in Medicine*, vol. 28, no. 2, 117-127.

- Eysenbach, G. and Jadad, A. R. (2001). "Consumer health informatics in the Internet age", in A. Edwards and G. Elwyn (eds.) *Evidence-based patient choice*, pp. 289-307, Oxford University Press
- Gustafson, D. H., Hawkins R. P., Boberg E. W., Mc Tavish F., Owens B., Wise M., Berhe H. and Pingree S. (2002). "CHESS: 10 years of research and development in consumer health informatics for broad populations, including the underserved", *International Journal of Medical Informatics*, vol 65, no. 3, 169-177
- Illich, I. (1975). *Limits to Medicine – Medical Nemesis: The expropriation of health*, Marion Boyars- Ideas in Progress Series
- Jones, R. (2000). "Development in consumer health informatics in the next decade", *Health Libraries Review*, vol. 17, no.1, 26-31
- Lafky, D. B., Tulu B. and Horan T. A. (2006). "Information Systems and Health Care X: A User-Driven Approach to Personal Health Records", *Communications of the Association for Information Systems*, vol. 17, 1028-1041
- Lewis, D., Eysenbach G., Kukafka R., Stavri P.Z. and Jimison H. (eds.) (2005). *Consumer Health Informatics – Informing Consumers and Improving Health Care*. Springer - Health Informatics Series
- Nurminen, M. I. (2005). "e-Man and His e-Mancipation", in Bertelsen et al. (eds.) *Between Sense and Sensibility – Proceedings of the 4th decennial conference on Critical Computing*, Aarhus, Denmark
- Ojima, M., Hanioka T., Kuboniwa M., Nagata H. and Shikuishi S. (2003). "Development of Web-based intervention system for periodontal health: a pilot study in the workplace", *Medical Informatics & The Internet Medicine*, vol. 28, no. 4, 291-298
- Orlikowski, W. and Beath C. M. (1994). "The Contradictory Structure of Systems Development Methodologies: Deconstructing the IS-User Relationship in Information Engineering", *Information Systems Research*, vol. 5, no. 4, 350-377
- Pratt, W., Unruh K., Civan A. and Skeels M. (2006). "Personal Health Information Management", *Communications of the ACM*, vol. 49, no. 1, 51-55
- Tan, Joseph (2005). "E-health records – The lifeblood of E-Health Care", in J. Tan (ed.) *E-Health Care Information Systems*, pp. 91-116, Jossey-Bass, San Francisco, USA