INTERNATIONAL CONFERENCE

INFORMATION SYSTEMS 2013
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREWORD</td>
<td>xi</td>
</tr>
<tr>
<td>PROGRAM COMMITTEE</td>
<td>xiii</td>
</tr>
<tr>
<td>KEYNOTE LECTURE</td>
<td>xvii</td>
</tr>
</tbody>
</table>

## FULL PAPERS

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATTERNS-BASED BUSINESS PROCESS MODELLING: DEFINITION AND CLASSIFICATION</td>
<td>3</td>
</tr>
<tr>
<td>Laden Aldin and Sergio de Cesare</td>
<td></td>
</tr>
<tr>
<td>IMPROVING PROJECT PERFORMANCE USING DEPENDENCY CYCLE EXTRACTION AND ANALYSIS</td>
<td>13</td>
</tr>
<tr>
<td>Matin Mavaddat, Stewart Green and Jin Sa</td>
<td></td>
</tr>
<tr>
<td>MODELLING THE IMPLEMENTATION OF AN ORGANIZATION: MAPPING ONTOLOGICAL TRANSACTIONS INTO ACTIVITY DIAGRAMS</td>
<td>22</td>
</tr>
<tr>
<td>Antonio Gonçalves, Pedro Sousa and Marielba Zacarias</td>
<td></td>
</tr>
<tr>
<td>IT OPERATIONAL RISK MANAGEMENT PRACTICES IN AUSTRIAN BANKS: PRELIMINARY RESULTS FROM EXPLORATORY CASE STUDIES</td>
<td>30</td>
</tr>
<tr>
<td>Stefan Bauer and Edward W. N. Bernroider</td>
<td></td>
</tr>
<tr>
<td>A FUZZY EXTENSION OF MAGERIT METHODOLOGY FOR RISK ANALYSIS IN INFORMATION SYSTEMS</td>
<td>39</td>
</tr>
<tr>
<td>Eloy Vicente, Antonio Jiménez and Alfonso Mateos</td>
<td></td>
</tr>
<tr>
<td>VISUALIZATION OF GEO-REFERENCED ENTITY: AN ASPECT-ORIENTED PATTERN</td>
<td>47</td>
</tr>
<tr>
<td>Armanda Rodrigues, Sara Silva and João Araújo</td>
<td></td>
</tr>
<tr>
<td>UNDERSTANDING of E-COMMERCE IS THROUGH FEATURE MODELS AND THEIR METRICS</td>
<td>55</td>
</tr>
<tr>
<td>Kestutis Valincius, Vytautas Stuikys and Robertas Damasevicius</td>
<td></td>
</tr>
<tr>
<td>UML CLASS DIAGRAMS – A COMPARATIVE STUDY ON APPROACHES TO FINITE SATISFIABILITY VERIFICATION</td>
<td>63</td>
</tr>
<tr>
<td>Paulo Bastos and Pedro Ramos</td>
<td></td>
</tr>
</tbody>
</table>
LEAVING THE HAPPY PATH: HANDLING EXCEPTIONS IN BUSINESS PROCESSES
Matthias Kurz, Matthias Lederer and Sebastian Huber

MULTI-CRITERIA ANALYSIS AND MODELING WITH GIS FOR THE LOCATION OF LANDFILLS: A CASE STUDY IN THE SOUTHERN REGION OF SANTIAGO ISLAND, CAPE VERDE
Adilson Cabral and Jorge Ferreira

INFORMATION SYSTEMS DEVELOPMENT PROJECTS AND THE SIMPT 2.0 CASE: HOW TO TURN AN ANTICIPATED FAILURE INTO A SUCCESS
Tommaso Federici, Umberto Crisalli, Danilo Scerbo and Alessio Maria Braccini

CHIEF INFORMATION OFFICERS’ PERCEPTIONS OF IT PROJECTS SUCCESS FACTORS IN SAUDI ARABIAN PUBLIC ORGANIZATIONS: AN EXPLORATORY STUDY
Abdulaziz I. AlMajed and Pam Mayhew

HIGHWAY INCIDENT DETECTION BASED ON PROBE CAR DATA
Hiroto Akatsuka, Atsuhiro Takasu, Kenro Aihara and Jun Adachi

A SELF-EFFICACY THEORY IN OPERATIONAL EFFICIENCY IMPROVEMENT OF HUMAN RESOURCE INFORMATION SYSTEMS
O. Akeem Adenuga and Ray M. Kekwaletswe

CLASSIFICATION RULES FOR REQUIREMENTS OBSERVATION
Takako Nakatani, Toshikazu Sano, Michitaro Okano, Narihito Kondo, Yukiko Fujitwara, Ryu Nakazato, Mari Inoki, Shozo Hori, Toshihiko Tsumaki, Michio Tsuda and Keiichi Katamine

A CASE STUDY OF A LARGE EUROPEAN FOOD RETAILER
Marius Janson

THE SPECIFICITY OF SOFTWARE FOR DISTRIBUTED ORGANIZATIONS – THE PROPOSAL OF AN ENTERPRISE MODEL
Jędrzej Wieczorkowski and Przemysław Polak

VALUE ENCOUNTERS IN PLATFORM AS A SERVICE: INFORMING THE STUDY OF VALUE COCREATION
Andreas Nilsson and Johan Magnusson

INVESTIGATING THE EFFECTS OF INNOVATIVE TECHNOLOGY ON SMARTPHONE USAGE WITH AFFORDANCE THEORY
Chin-Fu Ho and Jo-Peng Tsai

TESTING COLLABORATIVE SOFTWARE ACQUISITION MODEL (COSA) FOR COTS PACKAGE ACQUISITION
Torsti Rantapuska

ENTERPRISE SYSTEM POST-IMPLEMENTATION USE OF SALES PROCESSES BY GREEK SMES
Marios Mantakas and Dimitris Doukas

A RISKS-DRIVEN APPROACH TO OUTSOURCING AND REVERSIBILITY IN INFORMATION SYSTEMS
Walid Al-Ahmad and Abedallah Al-Oqaili
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPM, OPEN SOURCE AND SOA -- MISSION IMPOSSIBLE?</td>
<td>183</td>
</tr>
<tr>
<td>Martin Schöpple, Philipp Brune and Heiko Gewald</td>
<td></td>
</tr>
<tr>
<td>THE DESIGN SCIENCE RESEARCH METHODOLOGY FOR IT PROJECT MANAGEMENT</td>
<td>191</td>
</tr>
<tr>
<td>Joseph M. McQuighan and Robert J. Hammell II</td>
<td></td>
</tr>
<tr>
<td>THE OWL-S EXTENSION FOR THE PERSVATIVE SYSTEM</td>
<td>199</td>
</tr>
<tr>
<td>Fatma Achour, Anis Jedidi and Faiez Gargouri</td>
<td></td>
</tr>
<tr>
<td>ROLE OF WEB PERSONALIZATION IN CONSUMER TECHNOLOGY ACCEPTANCE</td>
<td>207</td>
</tr>
<tr>
<td>K. Vinodh and Saji K Mathew</td>
<td></td>
</tr>
<tr>
<td>INTEREST AREA ANALYSIS OF PERSON AND GROUP USING LIBRARY’S CIRCULATION RECORDS</td>
<td>215</td>
</tr>
<tr>
<td>Toshiro Minami</td>
<td></td>
</tr>
<tr>
<td>ACTIVITY ANALYSIS OF FACTORS INFLUENCING SECONDARY SCHOOL TEACHERS’ ADOPTION AND INTEGRATION OF ICTs INTO TEACHING</td>
<td>223</td>
</tr>
<tr>
<td>Topoyame Susan Maselesele and Raymond M. Kekwaletswe</td>
<td></td>
</tr>
<tr>
<td>SOCIAL PRESENCE AND CONTEXT AWARENESS IN A SOCIAL MEDIA LEARNING ENVIRONMENT</td>
<td>231</td>
</tr>
<tr>
<td>Mashitishi Benson Phuruasi, Dumisani Nkosinathi Tseta and Raymond Mompoloki Kekwaletswe</td>
<td></td>
</tr>
<tr>
<td>DESIGN AND DEVELOPMENT OF A MASHUP-BASED APPLICATION TO SUPPORT ORGANIZATIONS’ COMPLIANCE TO ISO27001</td>
<td>239</td>
</tr>
<tr>
<td>Marina Gavrilaki, Angelika Kokkinaki and Ioanna Dionysiou</td>
<td></td>
</tr>
<tr>
<td>SHORT PAPERS</td>
<td></td>
</tr>
<tr>
<td>ANALYZING IT IMPLEMENTATIONS</td>
<td>251</td>
</tr>
<tr>
<td>Alina Andreica</td>
<td></td>
</tr>
<tr>
<td>A MODEL TO MANAGE THE SOFTWARE ESTIMATION PROCESS THROUGH MATURITY LEVELS AND SERVICES</td>
<td>256</td>
</tr>
<tr>
<td>Bruno Omena Mesquita and Rodolfo Miranda de Barros</td>
<td></td>
</tr>
<tr>
<td>WORKFLOW INTEGRATION INTO INFORMATION SYSTEMS FOR BUSINESS PROCESSES OF EUROPEAN COLLABORATIVE PROJECTS</td>
<td>261</td>
</tr>
<tr>
<td>Klaus Bittner, Daniel Kimmig, Iris Warlo and Steffen Scholz</td>
<td></td>
</tr>
<tr>
<td>SOCIAL MEDIA READINESS IN SMALL BUSINESSES</td>
<td>267</td>
</tr>
<tr>
<td>Geetha Abeysinghe and Aisha Yaquob Alsobhi</td>
<td></td>
</tr>
<tr>
<td>FACTORS OF ENTERPRISE RESOURCE PLANNING (ERP) SYSTEMS IMPLEMENTATION IN A LIBYAN OIL COMPANY</td>
<td>273</td>
</tr>
<tr>
<td>Almahdi M. S. Ibrahim</td>
<td></td>
</tr>
<tr>
<td>THE ASPECTS WEIGHTINESS AND INVASIVENESS IN CONTEXT OF INTEGRATION</td>
<td>278</td>
</tr>
<tr>
<td>Fred Stefan, Martin Pero and Stefan Kühne</td>
<td></td>
</tr>
</tbody>
</table>
AN INVESTIGATION OF THE CONTEXTUAL FACTORS AFFECTING THE IMPLEMENTATION OF QUALITY MANAGEMENT IN IT DEPARTMENTS IN SAUDI ARABIA
Khalid I. AlShitri and Abdulmohsen Abanumy

ISSUES ASSOCIATED WITH CITIZENS IN DEVELOPING COUNTRIES TRUSTING THE SECURITY OF ON-LINE SERVICES
Ahmad Alenezi and Saad Amin

WHO ARE WE? IDENTIFYING AND DEFINING THE INFORMATION SYSTEMS (IS) DISCIPLINE BY A SET OF PRINCIPLES
Deborah Bunker

GUI GENERATION BASED ON USER INTERFACE GUIDELINES
Kazuya Sugiuchi, Junko Shirogane, Hajime Iwata and Yoshiaki Fukazawa

APPLYING LESSONS LEARNED AS AN IMPROVED METHODOLOGY FOR SOFTWARE PROJECT MANAGEMENT
Anderson de Souza Góes, Marco Hisatomi, Bruno Omena Mesquita and Rodolfo Miranda de Barros

CONTRIBUTION OF KNOWLEDGE MANAGEMENT SYSTEMS TO TRANSACTIONAL MEMORY SYSTEMS DEVELOPMENT
Pascale Nassar Hatem

COMMUNICATION MODEL FOR IMPROVING KNOWLEDGE CAPTURE IN COTS-BASED SYSTEMS
Anat Segal-Raviv, Meira Levy and Irit Hader

SUPPORT FOR NOVICE SPECIALISTS IN REMOTE CONSULTATION
Hiroshi Yajima, Kota Shimura, Manabu Kurosawa, Manabu Kurosawa and Jyun Sawamoto

HOW BIG DATA TRANSFORMS THE IT DEPARTMENT TO A STRATEGIC WEAPON
Michael Möhring, Rainer Schmidt, Nadja Wolfrum, Marina Kammerer, Stefan Maier and Sven Höritz

JOB SATISFACTION AMONG IT PROFESSIONALS IN THE PUBLIC SECTOR IN SAUDI ARABIA
Khalid I. Alshitri and Abdalmohsen Abanumy

ACQUISITION OF CHARACTERISTIC TREE PATTERNS WITH VLDC’S BY GENETIC PROGRAMMING
Shohei Nakai, Tetsuhiro Miyahara and Tetsuji Kuboyama

NFC CITY: CO-LOCATING NFC SERVICES IN A MULTI-SERVICE TRIAL APPROACH
Dag Slettemeids, Bente Evjemo, Sigmund Akselsen, Arne Munch-Ellingsen, Sindre Wolf and Victoria Jørgensen

PERSONALIZED ADAPTIVE SYSTEM FOR TERM ENROLLMENTS BASED ON CURRICULUM RECOMMENDATIONS AND STUDENT ACHIEVEMENT
Vangel V. Ajanovski

ICT: THE STONE GUEST IN THE IMPLEMENTATION OF PERFORMANCE MANAGEMENT SYSTEM. THE CASE OF ITALIAN ARMY
Armando Suppa, Alessandro Zardini, Cecilia Rossignoli and Marco De Marco
INVESTIGATING THE DIRECT EFFECT OF INTRINSIC MOTIVATION ON LEARNERS’ BEHAVIOURAL INTENTION
Abdullah Al-Aulamie, Ali Mansour and Herbert Daly

REFLECTION PAPERS

EVALUATION BY USING THE INFORMATION SYSTEM SUCCESS MODEL
Hans-Peter Steinbacher

USING THE FLOW MODEL TO INCREASE IT STAFF PRODUCTIVITY
Derek Smith

SUPPORTIVE ICT TOOLS IN AID OF INTERACTIVE POLICY-MAKING
Dóra Őri

REVOLUTIONS 20TH AND 21ST CENTURIES: ARTIFACT, IMPLEMENTATION, PROCESS
W. Brett McKenzie

POSTERS

INTELLIGENT CLASSROOM INFORMATION SYSTEM USING SENSING DATA AND PERSONAL RECORDS
Masaki Fujisawa, Hiroshi Sugimura, Hiroto Hoshino and Kazunori Matsumoto

TIME-SERIES DATAMINING SYSTEM WITH ANNOTATED INFORMATION
Hiroto Hoshino, Hiroshi Sugimura and Kazunori Matsumoto

IMPROVING THE SECURITY OF MOBILE CLOUD USING BIOMETRIC AUTHENTICATION (ISMCBA)
Iehab ALRassan and Hanan AlShaher

VISUAL EXPLORATIVE INTERFACES FOR THE ACM DIGITAL LIBRARY
Xia Lin, Mi Zhang, Haozhen Zhao and Jan Buzylowski

NFC FITNESS GUIDE
Arne Munch-Ellingsen, Sigmund Akselsen, Dag Slettemeås, Bente Evjemo, Simon Andreas Engstrom Nistad and Alexander Svendsen

DOCTORAL CONSORTIA

THE IMPACT OF ORGANISATIONAL SUBCULTURES ON THE ENTERPRISE ARCHITECTURE PROCESS
Hella Niemietz
AUTHOR INDEX
FOREWORD

These proceedings contain the papers and posters of the International Conference Information Systems 2013, which was organised by the International Association for Development of the Information Society, in Lisbon, Portugal, 13-15 March 2013.

The International Conference Information Systems aims to provide a forum for the discussion of IS taking a socio-technological perspective. It aims to address the issues related to design, development and use of IS in organisations from a socio-technological perspective, as well as to discuss IS professional practice, research and teaching. A set of key areas has been identified. However, these do not aim at being prescriptive, or set in stone, and any innovative contributions that do not fit into these areas have also been considered.

The following main areas have been object of paper, poster and doctoral submissions:

- IS in Practice, Technology Infrastructures and Organisational Processes
- IS Design, Development and Management Issues and Methodologies
- IS Professional Issues
- IS Research
- IS Learning and Teaching

The International Conference Information Systems 2013 had 162 submissions from 31 countries. Each submission has been anonymously reviewed by an average of 4 independent reviewers, to ensure the final high standard of the accepted submissions. Out of the papers submitted, 30 got blind referee ratings that published them as full papers, which means that the acceptance rate was 19%. Some other submissions were published as short papers, reflection papers, posters and doctoral papers. The best papers will be selected for publishing as extended versions in the IADIS Journal on Computer Science and Information Systems (ISSN: 1646-3692) and other selected journals.

The conference, besides the presentation of full papers, short papers, reflection papers, posters and doctoral papers also includes a keynote presentation from an internationally distinguished researcher. We wish to thank Richard Vidgen, Professor of Systems Thinking from the Department of Management Systems, Hull University Business School, UK, for accepting our invitation as keynote speaker.

As we all know, a conference requires the effort of many individuals. We would like to thank all members of the Program Committee (185 top researchers in their fields) for their hard work in reviewing and selecting the papers that appear in the book of the proceedings.
Last but not the least, we hope that everybody will have a good time in Lisbon and we invite all participants for the next year edition of the International Conference Information Systems 2014.

Miguel Baptista Nunes, University of Sheffield, United Kingdom
Pedro Isaías, Universidade Aberta (Portuguese Open University), Portugal
Program Co-Chairs

Professor Philip Powell, Executive Dean, University of London, UK
Conference Chair

Lisbon, Portugal
March 2013
PROGRAM COMMITTEE

PROGRAM CO-CHAIRS
Miguel Baptista Nunes, University of Sheffield, United Kingdom
Pedro Isaías, Universidade Aberta (Portuguese Open University), Portugal

CONFERENCE CHAIR
Professor Philip Powell, Executive Dean, University of London, UK

COMMITTEE MEMBERS

Abdelkrim Meziane, Cerist, Algeria
Abdu Almamou, University Lusofona, Portugal
Ada Pateli, Ionian University, Greece
Aggeliki Tsohou, Brunel University - London, United Kingdom
Agnes Front, Lig-sigma, France
Alexei Tretiakov, Massey University, New Zealand
Alexis Tejedor, Technological University Of Panama, Panama
Alice Shemi, University Of Botswana, Botswana
Amelia Badica, University Of Craiova, Romania
Anastasia Konstantelou, University Of The Aegean, Greece
Andras Gabor, Corvinus University, Hungary
Andrea Kienle, University Of Applied Sciences Dortmund, Germany
Andrea Ko, Corvinus University Of Budapest, Hungary
Andreas Oberweis, Karlsruhe Institute of Technology (KIT), Germany
Angelika Kokkinaki, University Of Nicosia, Cyprus
Annelie Ekelin, Linnaeus University, Sweden
Anza Akram, Anza Management Consulting Firm, USA
Banimira Slavova, SAP Research, South Africa
Bulend Terzioglu, Australian Catholic University, Australia
Carlos Blanco, Universidad De Cantabria, Spain
Carlos Cares, University Of La Frontera, Chile
Carmine Gravino, University Of Salerno, Italy
Carsten Maple, University Of Bedfordshire, United Kingdom
Catalina Mostaccio, University Of La Plata, Argentina
Christian Nielsen, University Of Dallas, USA
Christos Kalloniatis, University Of The Aegean, Greece
Claudia Pons, Universidad Nacional De La Plata, Argentina
Corine Cauvet, Université Aix-marseille 3, France
Corrado Loglisci, University Of Bari, Italy
Dashun Wang, Northeastern University, USA
David García Rosado, University Of Castilla-la Mancha, Spain
Debasis Giri, Haldia Institute Of Technology, India
Demetrios Sarantis, National Technical University Of Athens, Greece
Dick Ng’ambi, University Of Cape Town, South Africa
Dimitris Gouscos, University Of Athens, Greece
Dimitris Karagiannis, University Of Vienna, Austria
Dimitris Kardaras, Athens University Of Economics And Business, Greece
Dimitris Panopoulos, National Technical University Of Athens, Greece
Dimitris Papakiriakopoulos, Athens University of Economics and Business, Greece
Dimitris Rigas, De Montfort University, United Kingdom
Domenico Redavid, University Of Bari, Italy
Eddie Soulier, Université De Technologie De Troyes, France
Edward Bernroider, Vienna University of Economics and Business, Austria
Efthimios Tambouris, University Of Macedonia, Greece
Eija Koskivaara, University Of Turku, Finland
Eleana Asimakopoulou, University of Bedfordshire, United Kingdom
Eleutherios Papathanassiou, Athens University Of Economics And Business, Greece
Ellie Georgiadou, Middlesex University, United Kingdom
Elmarie Venter, Sap Research Pretoria, South Africa
Emel Aktas, Brunel University, United Kingdom
Euripides Loukis, University Of The Aegean, Greece
Faiez Gargouri, Institut Superieur D’informatique Et De Multimedia, Tunisia
Faith-michael Uzoka, Mount Royal University, Canada
Fang Zhao, American University In Sharjah, United Arab Emirates
Farhi Marir, London Metropolitan University, United Kingdom
Farid Meziane, Salford University, United Kingdom
Fenareti Lampathaki, National Technical University Of Athens, Greece
Francisco Jose Silva Mata, Cenatav, Cuba
Francky Trichet, University Of Nantes, France
François Bergeron, TELUQ, Canada
Geetha Abeysinghe, Middlesex University, United Kingdom
George Giannakopoulos, Skel Lab - NCSR Demokritos, Greece
Gertrudes Macueve, Universidade Eduardo Mondlane, Mozambique
Goran Velinov, University Ss. Cyril And Methodius Skopje, Macedonia
Gregory Chondrocoukis, University Of Piraeus, Greece
Hanhuai Shan, University Of Minnesota, USA
Hans Borgman, ESC-Rennes & Leiden University, France
Hans-Peter Steinbacher, University Of Applied Sciences, Austria
Haralambos Mouratidis, University Of East London, United Kingdom
Harekrishna Misra, Institute Of Rural Management Anand, India
Hisham Al-mubaid, University Of Houston, USA
Ian Allison, Robert Gordon University, United Kingdom
Ioanna Chini, University Of Sussex, United Kingdom
Ioanna Dionysiou, University Of Nicosia, Cyprus
Ioannis Kopanakis, Technological Educational Institute Of Crete, Greece
Miria Grisot, University Of Oslo, Norway
Mirjana Ivanovic, University In Novi Sad, Serbia
Mirjana Pejic-bach, University Of Zagreb, Croatia
Mohamed Sheriff, Middlesex University, United Kingdom
Mouath Hourani, Amman University, Jordan
Mounia Fredj, Ensias, Morocco
Mountaz Hascoet, Universite Montpellier II, France
Nik Bessis, University Of Derby, United Kingdom
Nikos Papakostas, University Of Patras, Greece
Nineta Polemi, University Of Pireaus, Greece
Ning Ruan, Google Inc., Usa
Norah Power, University Of Limerick, Ireland
Omar Boussaid, University Lyon2, France
Ounsa Roudies, Ecole Mohammadia D'ingénieurs (emi), Morocco
Pascal Salembier, Université De Technologie De Troyes, France
Pierre Dal Zotto, Grenoble Ecole De Management, France
Rainer Alt, University Of Leipzig, Germany
Rania Hatzi, Harokopio University Of Athens, Greece
Redouane El-amrani, Reims Management School, France
Reima Suomi, Turku School of Economics, University of Turku, Finland
Rob Kusters, Eindhoven University Of Technology, Netherlands
Roxana Giandini, Universidad Nacional De La Plata, Argentina
Said Assar, Telecom Business School, France
Sasikumar Punnekkat, Malardalen University, Sweden
Sebastien Fournier, Domaine Universitaire De St Jerôme, France
Seppo Sirkemaa, Turku University of Applied Sciences, Finland
Sietse Overbeek, University of Duisburg-Essen, Germany
Silvester Ivanaj, Icn Business School, France
Sokratis Katsikas, University Of Piraeus, Greece
Somkiat Kitjongthawonkul, Australian Catholic University, Australia
Sotiris Koussouris, National Technical University Of Athens, Greece
Soulla Louca, University Of Nicosia, Cyprus
Sozon Papavlasopoulos, Ionian University, Greece
Spyros Kokolakis, University Of The Aegean, Greece
Stan Karanasios, Leeds University Business School, United Kingdom
Stavros T. Ponis, National Technical University Athens, Greece
Stefano Berretti, University Of Florence, Italy
Stefano Ferilli, University Of Bari, Italy
Stefanos Gritzalis, University Of The Aegean, Greece
Stephen Burgess, Victoria University, Australia
Tarek Hamrouni, Faculte Des Sciences De Tunis, Tunisia
Tariq Khan, Brunel University, United Kingdom
Theodoros Ntouskas, University Of Piraeus, Greece
Vanessa Liu, New Jersey Institute Of Technology, Usa
Vasiliki Vrana, Technological Educational Institute Of Serres, Greece
Vassileios Chrissikopoulos, Ionian University, Greece
Vinod Kumar, Carleton University, Canada
Waleed Alsabhan, University Of Sharjah, United Arab Emirates
Willy Picard, Poznan University of Economics, Poland
Witold Abramowicz, The Poznan University Of Economics, Poland
Wojciech Cellary, Poznan University Of Economics, Poland
Xenia Mamakou, Athens University Of Economics And Business, Greece
Xenia Ziouvelou, Athens Information Technology, Greece
Xiaohui Liu, Brunel University, United Kingdom
Yanqing Duan, University Of Bedfordshire, United Kingdom
Yi Fang, Purdue University, Usa
Yiwei Gong, Delft Technical University, Netherlands
Yoan Pinzon, Universidad Nacional De Colombia, Colombia
Yong Yue, University Of Bedfordshire, United Kingdom
Zamira Dzhusupova, UNU-IIST, Macao
Zoltan Szabo, Corvinus University Of Budapest, Hungary
KEYNOTE LECTURE

ENGAGING WITH GRAND CHALLENGES:
CAN PRO-SOCIAL INFORMATION SYSTEMS (PROSIS) HELP CHANGE BEHAVIOURS?

By Professor Richard Vidgen
Professor of Systems Thinking, Department of Management Systems,
Hull University Business School, UK

Abstract

Grand Challenges - such as the eradication of extreme poverty, combating diseases, reducing carbon emissions, and increasing levels of human health and happiness - are problems that are: (i) difficult to solve, (ii) demand significant improvements in research, (iii) require great advances of knowledge, and (iv) rely on collaborative efforts from many disciplines and communities (Winter & Butler, 2011). We define the term pro-societal to include pro-social behaviors, ones that are altruistic and benefit society directly (e.g., charitable donations, volunteering, community engagement), and pro-self behaviors (e.g., eating a healthy diet, reducing household energy use, ceasing smoking), which are egoistic and benefit the individual directly. Pro-self behaviors benefit society indirectly, e.g., taking regular exercise will lessen the national cost of health care. ProSIS draws on theories of persuasion, self-determination, social presence, and social networks to understand how ICT artefacts can be deployed to engender and maintain behaviour change. Such ICT artefacts are considered to have persuasive affordances. The artefacts include software applications such as ambient information provision, social media and interactive games. These artefacts are ubiquitous and context-aware and may make use of neuro- and physio-sensing capabilities. We believe that IS will benefit significantly by becoming a willing partner with other disciplines in tackling society’s grand challenges and will benefit further from greater resource flows, new students, new faculties, and a greater legitimacy as a discipline (Winter & Butler, 2011).
Full Papers
PATTERNS-BASED BUSINESS PROCESS MODELLING: DEFINITION AND CLASSIFICATION

Laden Aldin¹ and Sergio de Cesare²

¹Faculty of Business and Management, Regents College London, Regent’s Park, London, UK
²Department of Information Systems and Computing, Brunel University, Uxbridge UB8 3PH, UK

ABSTRACT

Patterns have been a research area that has attracted significant interest of both researchers and vendors. One major problem is that pattern-based business process modelling is not commonplace and the process of discovering patterns is not clear. As a consequence, this paper is devoted to provide a clear definition of business process patterns and to present a list of formal and explicit business process patterns (BPP) that have been discovered using the Semantic Discovery and Reuse (SDR) methodological framework that synthesises best practices found in real projects from the financial and educational domains. The reason for undertaking this research is that modelling business processes more often involves applying and adapting patterns than inventing new ones. Thus, this research concluded that patterns simplify the process design by providing the immediate benefit of reduced modelling and reuse efforts and the longer-term benefit of greater consistency and standardisation. When discovered business process patterns are organised for reuse, they are more easily adopted, and yield even greater benefits to those who follow them.

KEYWORDS
Pattern, business process pattern, business process, model and generalisation.

1. INTRODUCTION

In the globalisation era, organisations have to deal effectively with the constant changes and therefore have to become agile, responsive and rapidly adaptive (Sidorova and Isik 2010). One way to achieve this is by enabling organisations to modify and improve their business processes (BP), so that organisations can deal with the changes in their environment and maintain their competitiveness.

Indeed, a recent common theme in the business process literature is the search for an approach that allows formalising domain knowledge into structure, hierarchy or patterns (Barros 2007, Arlow and Neustadt, 2003, Bohrer et al. 1998, Cline and Girou 2000, Fowler 1996, Sousa and Nills 1999), which provides the immediate benefit of reduced modelling and reuse efforts and the longer-term benefit of greater consistency and standardisation. These types of structures are also known as business process patterns (BPP) and can be reused for modelling organisational processes.

Mirroring the cross-functional nature and impact of patterns, the idea of patterns can be traced to Alexander (1977) and his description of a systematic method for architecting a range of different kinds of physical structures in the field of civil architecture. Moreover, research on patterns has been conducted within a broad range of disciplines from architecture (Alexander et al. 1977) to software engineering (Beck and Cunningham 1987, Coad 1992, Gamma et al. 1996, Hay 1996, Fowler 1997 and Eriksson and Penker, 2000) and more recently in process modelling (van der Aalst et al. 2003 and Malone et al. 2003). The diversity and multi-disciplinary nature of pattern research made it difficult to follow developments on all different fronts of pattern research. Notwithstanding, in business process modelling (BPM) the use of patterns is quite limited apart from few sporadic attempts proposed by the literature, pattern-based BPM is not commonplace (Aldin and de Cesare 2011). Existing business process patterns literature reviews, while highly instrumental in describing the various finding of process patterns research, but do not effectively combat the development of process patterns definition and classification to enable their future reuse because of their limited research scope and focus on specific patterns-related issues or initiatives.
The motivation for this research arose from the fact that organisations of today are becoming ever more focused on their business processes. This has resulted in an increasing interest in business process patterns, which can be used in order to understand where one can adopt best practices. However, one of the main issues in business process patterns is how to fully exploit patterns, they need to be defined in a structured, and even formal way. This paper therefore proposes to define business process patterns and classify a list of business process patterns based on the ontology and the representation of real-world semantics rather than just the inheritance relationship between verbs that refer to the represented business activity or the sequence of events/activities.

The remainder of this paper is structured as follows: Section 2 summarises the related work; Section 3 shows the proposed business patterns in detail, while business process application is presented in Section 4. Finally, Section 5 addresses the conclusions and future work.

2. BACKGROUND

The subject of business process patterns represents a topic that has been discussed at various stages among information systems (IS), organisational theory, and business process modelling researchers and practitioners.

Several business process pattern definitions are presented in the literature (Graml et al. 2008, Tran et al. 2011, Barros 2000, Gacitua-Decar and Pahl 2009). These definitions reflect the solution offered by the discovered patterns, as presented in Table 1.

<table>
<thead>
<tr>
<th>Business process patterns definition</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business process pattern describes a design solution to an operational business problem. The BP pattern provides a common vocabulary and the means to reuse the business process design solution as a building block for more complex processes.</td>
<td>Veronica Gacitua-Decar and Claus Pahl, 2009</td>
</tr>
<tr>
<td>Patterns are models that are sufficiently general, adaptable, and worthy of imitation that we can reuse them.</td>
<td>Graml et al. 2008</td>
</tr>
<tr>
<td>Business process pattern solution describes a (fragment of) process model that helps resolve the pattern’s problem.</td>
<td>Tran et al. 2011</td>
</tr>
<tr>
<td>BPP are generalized process models, including activities, flows connecting them and business logic, of how a business in a given domain should be run, according to best practices known.</td>
<td>Barros, 2000</td>
</tr>
</tbody>
</table>

In some studies, business process patterns are classified and discovered from defining business process model similarity search techniques (Aalst et al. 2003, Gacitua-Decar and Pahl 2009, Dumas and Garcia-Bañuelos, 2009), based on three complementary aspects of process models: (1) the labels attached to tasks, events and other model elements, (2) their graph structure (Structural Similarity), and (3) their execution semantics (Behavioural Similarity). The limitation in existing process model similarity search techniques tend to focus on the control-flow view of process models, neglecting data manipulation (e.g. data inputs/outputs), resource allocation, and restricted to the use of specific process modelling languages (Dumas and García-Bañuelos, 2009). Another form of classification by Ricardo Pérez-Castillo et al. (2010) proposed that a set of patterns consists of ten business process patterns grouped into three categories: (i) structural patterns deal with the built elements and their combinations such as process, task and sequence flows; (ii) data patterns deal with data objects and how these objects are related to other elements; and (iii) event patterns build all the elements involved in the event management. In this study the categorisation mainly relied on Business Process Modelling Notation (BPMN) elements, by pre-requesting the model to be presented in the BPMN modelling language, which limited their reuse.

Another category of business modelling patterns is represented by the patterns proposed by Malone et al. (2003). The MIT process handbook project established an online library for sharing knowledge about business processes, which organised hierarchically to facilitate easy process design alternatives. The hierarchy builds on an inheritance relationship between verbs that refer to the represented business activity. There is a list of eight generic verbs including create, modify, preserve, destroy, combine, separate, decide and manage. These business process patterns provide a systematic means of (re-) designing new processes by
finding a richer structured repository of process knowledge through describing, analysing and redesigning a wide variety of organisational processes. Finally this study classified the dependency between activities into three types of resource flow, fit and sharing, and builds the coordination knowledge taxonomy (classification structure) focusing on resource flow.

Theoretically, business process patterns are supposed to be useful to propagate process best practices, model processes in a flexible and reusable way, and reduce process modelling time. Practically, these benefits have not been completely obtained yet, especially the two latter ones. Despite the various discovered process patterns explained earlier, most of the earlier studies are informally defined and classified in the literature. This informality cannot help in reducing the modelling efforts and increasing modelling flexibility.

The work presented here attempts to address the above limitations, or at the very least, contribute toward suggesting an approach that can address such limitations. The basis of the proposed definition of business process pattern is ontology and the representation of real-world semantics. While we accept that formal representations are fundamental for enabling the automation of any use case related to BPM, we also recognise that previous research has been predominantly preoccupied with logical and internal consistency of models rather than the real world semantics of such representations. By real-world semantics we intend the mapping between symbols in a model and things in the real-world (e.g., a business organisation). This is consistent with Lowe’s definition of ontology according to which an ontology is “the set of things whose existence is acknowledged by a particular theory or system of thought” (E.J. Lowe in the Oxford Companion to Philosophy). In this research the philosophical definition is applied in conjunction with the current Semantic Web notion of ontology. When modelling the business processes we do so with the aim of accurately identifying the individual process elements, as they exist in an organisation. These real-world models are then represented in the Web Ontology Language (OWL) in order to allow for automatic inferencing of generalised process patterns. Interested readers can refer to Aldin et al. (2009) for a more complete explanation of the method that was developed for the modelling of process patterns.

Therefore, this mix of philosophical and computational ontologies is an attempt at addressing the issues presented above. In the sections that follow we will focus on defining and providing a classification list of business process patterns discovered by the Semantic Discovery and Reuse of Business Process Patterns methodological framework (SDR) (Aldin et al. 2009c).

3. BUSINESS PROCESS PATTERNS

3.1 Semantic Discovery and Reuse of Business Process Patterns Methodological Framework

Aldin et al. (2009b) based the Semantic Discovery and Reuse methodological framework on a dual lifecycle model as proposed by the domain engineering literature (Prieto-Daz, 1990). SDR defines two interrelated lifecycles as presented in Figure 1: (1) a lifecycle aimed at generating business process patterns and (2) a lifecycle aimed at producing business process models.
The first lifecycle, Semantic Discovery Lifecycle (SDL), initiates with the preparation of the organisational legacy assets and finishes with the production of business process patterns, which then become part of the pattern repository. The second lifecycle is the Semantic Reuse Lifecycle (SRL) and is aimed at producing business process models with the support of the patterns discovered during the SDL. In this framework the SRL is dependent on the SDL only in terms of the patterns that are produced by the SDL. The two lifecycles are, for all other purposes, autonomous and can be performed by different organisations.

The business process patterns that were used in this study derived from the financial and higher education domains. For the financial domain, process models were extracted from user and design documentation of three legacy systems each representing a specific subdomain; these were retail banking, insurance and mortgages. For the domain of higher education staff and student handbooks represented the main source of information. Overall about 50 process models were extracted. In broad terms the derivation of the process models followed three main phases: (1) data collection and organisation of the documentation, (2) interpretation of the documentation in order to derive business process diagrams and (3) discovery of patterns. It was in the final phase in which patterns classification and definition played a key role and it is this aspect of the overall approach that the following section will focus on.

### 3.2 Business Process Concepts and Patterns

Many definitions of business process have been proposed. Table 2 summarises five definitions found in the literature and extracts the main concepts emphasised by the respective authors (Aldin and de Cesare, 2011).

<table>
<thead>
<tr>
<th>Definitions</th>
<th>Concepts Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>A business process is the set of internal activities performed to serve a customer (Jacobson 1995).</td>
<td>Process – Activities – Serve - Customer</td>
</tr>
<tr>
<td>A business process is a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer. A business process has a goal and is affected by events occurring in the external world or in other processes (Hammer and Champy 1994).</td>
<td>Process – Activities - Input Output – Customer - Goal Event</td>
</tr>
<tr>
<td>A business process is simply a structured set of activities designed to produce a specified output for a particular customer or market. It implies a strong emphasis on how work is done within an organisation, in contrast to a product’s focus on what. A process is thus a specific ordering of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs: a structure for action. (Davenport 1992)</td>
<td>Process – Activities - Input Output – Customer - Product Time/place - Rules</td>
</tr>
<tr>
<td>Business Process is a lateral or horizontal organisational form that encapsulates the interdependence of tasks, roles, people, departments and functions required to provide a customer with a product or a service. (Earl 1994)</td>
<td>Process - Tasks (i.e. activities) Roles - Customer Product or Service</td>
</tr>
<tr>
<td>Business Process is a purposeful activity carried out collaboratively by a group, often crossing functional boundaries and invariably driven by outside agents or customers. (Ould 1995)</td>
<td>Process – Activities - Customer Purposeful (i.e. having a goal)</td>
</tr>
</tbody>
</table>
The concepts identified in Table 2 represent those elements that the business process community commonly and generally accepts as being fundamental in characterising business processes (Aldin et al., 2009c). These elements include:

- **Process**: A set of activities, events, etc. that together and cohesively delivers a service and/or a product.
- **Activity**: Specific behaviour carried out in an organisation.
- **Service and Product**: The observable outcome of value of a process. The traditional distinction between service and product is that the former is intangible while the latter is tangible.
- **Participant**: The types of actors or agents that take part in processes.
- **Goal**: The aim of a process. Goals are a special type of dissolution event normally corresponding to a predefined type of outcome for a business process. For example, the approval of a mortgage application.
- **Event**: An occurrence that takes place at a specific point in time and that is capable of inducing some observable behaviour (activity or process). Two types of events can be defined. Initiating events which trigger the start of a process or an activity and dissolution events which terminate a business process or an activity.
- **Resource**: Tangible (e.g., raw materials) or intangible (e.g., specific documents or information) things that are processed, manipulated, transformed, etc. by processes/activities. Resources that are required at the start of a process or activity are considered inputs, while resources that are produced by a process or an activity are considered outputs. Hence the relationships hasInput and hasOutput.

![Figure 2. Business Process Ontology.](image)

The BPO was initially represented informally in UML (Figure 2) and then converted to OWL in Protégé 4.0. Business process models of two domains (financial and educational) were derived from legacy system design documents and user manuals for the former and from staff/student handbooks for the latter. The method of extraction and interpretation followed to derive such models is documented in Aldin et al. (2009c). The models were then represented in OWL based on the ontology in Figure 2 and subsequently generalised to patterns at various level of extraction and classified as described in the following section. Process pattern discovery was carried out by identifying commonalities based on a mix of the core process elements of the BPO.
3.3 Business Process Patterns Definition

As mentioned previously, the literature proposes various definitions of process patterns. Most studies focus on different facets of process modelling as explained earlier. However, the SDR methodology and the current study focus on business process patterns that consider activities and events as not the only elements that define a business process; there are others such as participants, input and output resources, services, products and goals. For example, one may consider two processes producing similar types of outputs, but having limited overlap in the internal activities, as being a type of business process pattern with possibly a reduced level of reusability and over utility for the modeller.

The remainder of this section exemplifies the definition of different levels of patterns discovery. The BPO was used to drive the process patterns. The BPO as well as the processes extracted during data collection were represented in OWL and the ontologies modelled in Protégé 4.0 (Corcho et al. 2003). The identification of possible process pattern classes was carried out manually and their formal definitions were axiomatised in OWL. The OWL reasoner FaCT++ was executed within Protégé 4.0 to produce the different level pattern hierarchies, as defined below:

First, Business Process Patterns at a General Level: business process patterns at a general level are generated by being able to recognise the business process commonalities between two different organisations or domains, which can be used to generate the content of a process element. Often, in the process definition phase, process designers need to elaborate a detailed description for a process element. In such cases, process patterns can be used as building blocks to (re)design processes quickly. This is the most popular use, and to our knowledge, the unique use of process patterns proposed by the process community for process modelling. An example of business process pattern based on similar Inputs within two different domains (financial and education) is presented in Figure 3 and Figure 4.

Second, Domain Specific Business Process Pattern: business process patterns at a more specialised level are generated by being able to identify the business process commonalities between two different processes of the same organisation, which can be a business architect could adopt with the goal of increasing model reusability (Aldin and de Cesare 2011). The pattern in such cases is discovered and designed in a way that gives its different users the ability to expand the existing shared elements without altering the existing ones. These discovered business process patterns could be specialised to meet domain specific needs. An example of pattern based on similar Inputs within the processes of the education domain is presented in Figure 5 and 6 (Aldin and de Cesare 2011).
This type of pattern depends on the inputs that a business process requires as resources in order to achieve its ultimate goal(s). Thus, it generalises all the business processes that have similar input types within one domain. The reason to develop this type of pattern is to provide a practical way to approach the issues of which type of document should be used as a resource within different business processes, including its different versions and copies. It might be argued that this general model does not offer much for an organisation, but according to Ericksson and Penker (2000), who have developed a ‘Resources Use’ general model, this type of model is important to understand how resources can be used in one way for one process and in a totally different way in another process. Thus, neglecting the fact that an input can be used in different processes in different ways will in many cases lead to processes that do not make optimal use of its resources. Figures 5 and 6 provide an example of a process pattern class (i.e., BPUsesForms) obtained from this type of level of extraction rule. Finally, it is important to mention for future reuse there needs to be a way to classify them.

3.4 Business Process Patterns Classification

Pattern classifications in the literature reviewed earlier were mainly dependent on the modelling languages to discover patterns without describing and presenting the knowledge of the domain presented. Most of these works are designed towards presenting a certain language and then provide their patterns classification accordingly, i.e. they only deal with the modelling elements of process models represented with the help of a certain modelling language. However, the SDR methodology and the current study focus on business process patterns that do not consider activities and events as the only elements that define a business process; there are others such as participants, input and output resources, services, products and goals. At an organisational level, business process patterns reuse is very important (Tran et al. 2011), particularly in the stages of formulation of needs and definition of functional specifications to (re)design processes. We therefore classified the discoverable patterns into six types (Table 3) based on property restrictions related to the different elements of the BPO. Figure 7 represents the various levels of business process patterns achieved from the financial and educational domains. Using a taxonomical hierarchy for the different discovered models so that the details of the patterns are organised and made available in a human-readable format. Constructing a pattern hierarchy adds advantages such as (1) ease of adding and updating patterns, (2) making patterns retrieval more efficient and (3) a hierarchical model is simple to construct and operate on.

<table>
<thead>
<tr>
<th>Patterns Types</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similar Process Elements</td>
<td>This type of pattern depends on all or most of the elements of a process (activities, events, participant, Resources). It classifies business processes, which have most or all process elements of a similar type.</td>
</tr>
<tr>
<td>Similar Initiating Events</td>
<td>This type of pattern depends on the initiating event of a business process. It classifies all the business processes that have similar type initiating event to trigger their business processes.</td>
</tr>
<tr>
<td>Similar Goal Events</td>
<td>This type of pattern depends on the goal of a business process. It classifies all the business processes that have a similar type goal event to dissolve the process itself.</td>
</tr>
<tr>
<td>Similar Inputs</td>
<td>This type of pattern depends on the inputs that a business process needs to resource its processes. It classifies all the business processes that have similar input types.</td>
</tr>
<tr>
<td>Similar Outputs</td>
<td>This type of pattern depends on the outputs that a business process produces. It classifies all the business processes according to similar output types.</td>
</tr>
<tr>
<td>Similar Participants</td>
<td>This type of pattern depends on the participants that take part in a business process. It classifies all the business processes that have similar participant types.</td>
</tr>
</tbody>
</table>
Six categories of business process elements have been used to classify the various levels of business process patterns, e.g. BP with Client Participant is a process pattern that has been generalised according to the participant of the process; the authors can easily argue the benefit of this type of classification: (1) discovered patterns are of a business process type, and business processes consist of elements that construct its process. Those elements affect the behaviour of those business processes. Thus, discovering business process patterns using business process elements provide a powerful finding as each element has a distinct role in accomplishing the organisational processes, (2) Adding constraints to each type of discovered pattern helps modellers to both represent and use patterns of generalised behaviour in the sense that it would be possible to state a minimal set of necessary conditions that are required for the application of a certain pattern, to enable ease of reuse, and (3) This categorisation plays a key role in facilitating pattern documentation, maintenance, use, and reuse. Clarity and simplicity are considered major issues affecting business process patterns usefulness and value. Hence, the way these patterns are categories is designed to address the needs of various audiences and can be tracked easily.
Interestingly, from what has been discovered and explained previously, it can be argued that discovering patterns on multiple domains is advantageous since it (1) facilitates capturing greater details among the different domains and (2) improves the validity of the findings through the ability of undertaking comparisons and further generalisation across domains.

4. BUSINESS PROCESS PATTERNS APPLICATION

To design a new business process model normally the analyst is required to identify patterns that best satisfy the requirements of their context of use. If a business process pattern is an excellent fit to a set of requirements then it can be used without change, by simply following the pattern exactly to design our To-Be Model. Even when a standard pattern is not the best match to the requirements, the analyst might consider changing some of those requirements and adapting the pattern. Otherwise, the advantage gained by changing the pattern to better satisfy internal needs might be outweighed by new costs imposed on customers, external partners and services that can no longer use the pattern. However, sometimes analysts do need to adapt a pattern and make changes to fit the specific requirements of our context of use. Moreover, business process patterns - as independent abstractions of specific process models - might not be exactly replicated in an actual process. Rather, partial, inexact and often less abstract pattern instances take place.

Hypothetically, reuse helps reduce the process modelling effort and increase the quality of process modelling. However, this benefit is hardly obtained when reusing is realised manually on complex and huge designing processes. In most cases, it is desirable to develop automatic operators for manipulating and reusing process models. Such automatic operators ensure correct applications of reusable process models and shorten process modelling. This is part of a future study of using the second lifecycle of the Semantic Reuse Lifecycle of the SDR method.

5. CONCLUSION

The necessity of changing the way in which organisations do business and provide value in order to survive and flourish in a high-tech market has been recognised by both academics and industries. Nevertheless, the resulting SDR methodology is intended to adequately support business process modelling. It allows the capture and recording of pattern discovery and evolvement and their reuse in future developments.

Due to the limited data source access used from the educational domain, further generalisation across the two domains would be achieved, an example is the ‘Create Product Type’ pattern of the financial services domain. Despite this the authors could not find similar processes in the academic institution, thinking of universities creating new course types enable to further generalise the two domains patterns. Another example is the ‘Create Client Information’ pattern of the financial services domain since a student may represent a type of client for a university and creating student information is a must within the universities. Those two examples and more would offer further generalisations that can be identified in future work across the financial and educational domains with access to a greater amount of data sources.

Our research is continuing in several directions. Firstly, we are applying the full version of the developed patterns in an industrial domain to check their validity and solve the problem of domain reuse in modelling organisational processes, which exist in current business process patterns. Secondly, the SDR is being extended to include domains not included in it. Thirdly, we are working on the application of the reuse lifecycle. Finally, we are improving the way to classify these discoverable to facilitate their practical use.

REFERENCES

Arlow, J. and Neustadt, I. (2003), Enterprise Patterns and MDA, Addison Wesley, Boston, MA.


ABSTRACT
To fulfill the objectives of a software development project in an organisation, project participants create different kinds of dependencies on each other. These dependencies and their types reveal a lot of dependency information about processes that are being followed to complete a project: e.g. project team structure, culture and communication patterns. Extracting these dependencies, which represent fragments of business process execution, and helping the analysts to find the root causes of some of the organizational problems in the projects is a non-trivial task; and business analysts and consultants might need to spend a lot of time doing this, using conventional analysis methods. Using a new concept called dependency cycles, this paper introduces a method for extracting these dependencies from conversation logs, and shows how they can be analyzed in order to extract patterns that could help an organization to improve its structure, communication forms, culture and business processes.

KEYWORDS
Dependency cycles, business process modeling, business process optimisation, communication patterns

1. INTRODUCTION
Large project teams usually suffer from many organizational problems such as dysfunctional team structures (e.g. dysfunctional hierarchies), cultural differences that cause misunderstanding, bad organisational culture (e.g. lack of authority, cyclic referral of responsibilities) and the complexity of the communication patterns and processes that they follow in order to fulfill the objectives of the project. These problems cause the project teams to underachieve, prevent the project from achieving its business goals, and create a lot of inefficiencies (Hoegl, M., 2005). Using conventional methods, investigating the problem with the project team and finding the actual source of problem is a non-trivial task. Usually consultants and business analysts need to spend an extensive amount of time with the team using a variety of techniques, such as interviews, questionnaires and observational methods such as ethnography, to try to find the root causes of the problems (Cadle, J., Paul, D. & Turner, P., 2010).

The paper introduces the notion of dependency cycles between roles working on a project in order to tackle these problems. It also introduces three theories (see next section) and explains how they contribute to the dependency cycle approach. The paper goes on to present principles and heuristics for extracting dependency cycles from conversation logs, like email corpora, and discusses how analyses based upon such extractions can be used to appraise a project’s processes, team structure and patterns of communication.

This technique of using conversation logs, such as email messages that have been sent and received about the project’s tasks and goals and objectives, is aiming to reduce the amount of time necessary for analyzing the project team dynamics, communication patterns, processes etc. and to reveal the problems more quickly and efficiently. It also does not suffer from ethnographic approaches’ shortcomings such as:

- Heisenberg principle: People usually do not work in the same way when they are being observed or, more formally, the results of the observation are affected by the presence of the observer.
- Interrupt ‘business-as-usual’: this means someone’s watching and asking questions will interrupt peoples’ usual way of work and might decrease their performance.
- It is difficult to observe knowledge workers’ work without asking many questions.
- Not observing the typical working day that is a good representative of a typical work pattern.
And, being based on more documented evidence, the proposed technique is less subjective than conventional analysis methods.

The design-science research method (Hevner, A., 2007) (Hevner, A. & Chatterjee, S., 2010), and, more specifically, Peffers’ et. al.’s (2006) process model for design-science research has been used for carrying out this research. Their process model consists of the following steps:

1. Problem identification and motivation
2. Objectives of a solution
3. Design and development
4. Demonstration
5. Evaluation
6. Communication

We have tried to cover the first and second steps – problem identification and motivation and objectives of a solution - in the introduction section of the paper by identifying the problem that we are trying to solve and the motivations, and also by defining in what aspects this new solution is going to supersede the previous solutions to this problem. In section 2 we will cover the third step of the process – design and development - by introducing the artifact of this research, i.e. the new technique, and demonstrating how it has been designed and developed based on sound theories. Section 3, using a case study and applying the proposed technique to it, will cover the fourth step of the process - demonstration. In section 4 the outcomes of the case study will be evaluated; which will cover the fifth step of the process - evaluation. And the sixth step – communication (publication) – is covered in part by this paper.

2. DESIGN AND DEVELOPMENT OF THE TECHNIQUE

2.1 Theoretical Basis (Strategic Dependency Models, Conversation for Action Diagrams and Episodic Memory)

Dependencies between different business process participants (project team members) and the important role that it plays is not a new concept. Eric Yu (2010) in the i* framework, introduces a model called strategic dependency model (see figure 1). SD tries to capture strategic dependency of different business process participants to fulfill a business objective. In other words the model tries to capture how different business roles depend on each other to achieve a particular business goal. Eric Yu(2010) introduces four different dependency types: 1. Goal dependency 2. Task dependency 3. Resource dependency 4. Soft goal dependency. He argues that creating the SD model based on these dependency types significantly contributes to the understanding of the business processes of an organisation.

The below, very simple, strategic dependency model (figure 1) shows how different actors (agents) depend on each other in a meeting planning process. Each dependency consists of three main elements, depender, dependee and dependum. Depender is the person who depends on someone to achieve a goal, complete a task or deliver a resource. Dependee is the person who the depender has depended on and finally dependum is the subject of the dependency, the “thing” that the depender has depended on the dependee to deliver (task, goal or resource). For example, the figure 1 diagram shows that the meeting initiator (depender) has a goal dependency on the meeting participant (dependee) to attend the meeting (dependum). He or she also has some resource dependency on the meeting participant to provide him or her with exclusion dates and preferred dates. The meeting participant depends (resource dependency) on the initiator to propose a date; and, eventually, the initiator depends on the participant to agree on a date and time.
Moving on to the second theory, Winograd et al. (1987) put forth the conversation for action theory based on Searle’s (1969) speech act theory or, in computer science world, language action perspective. They argue that business processes are networks of conversations that occur between different business process participants about achieving organisational goals. They introduce the conversation for action diagram (see figure 2) and believe “speech acts are not individual unrelated events, but participate in large conversational structure” (Winograd, 1988). The next paragraph explains the conversation for action idea and shows how, in our work, it has been combined with the strategic dependency model idea.

The concept of “dependency cycles” that is inspired by the i* framework’s SD model and conversation for action theory is a new concept. It combines the SD model concepts with the Winograd et al. (1987) conversation for action theory and tries to capture what drives these dependencies and what role they play in moving a business process forward. The dependency cycles represent fragments of business process instances as they follow the conversation for action diagram states. They show how people converse and, in conversing, depend on each other to fulfill an objective. A dependency cycle starts with a request and ends with either a withdrawal, a rejection of the result, or the declaration of the fulfillment of the objective of the dependency cycle i.e. with the dependum of the dependency cycle. Dependency cycles have the same types as the dependency types in i* framework. So there is a goal dependency cycle, a task dependency cycle, a resource dependency cycle and a soft goal dependency cycle. The type of the dependency cycle depends on the conversation that contains the request concept. A request either defines whether the initiator is asking for
some sort of objective to be fulfilled, resource to be delivered, task to be done; or it is a soft goal that restricts the qualities of one of the other dependency types.

Dependency cycles consist of two dimensions. In one dimension they demonstrate the sequence of occurrence of main dependencies that eventually result in meeting the business goal of the specific business process under investigation. In the other dimension they show different dependency types that are created in nested dependency cycles to fulfill a higher-level dependency cycle goal, or, in other words, to deliver a higher-level dependency cycle dependum. These dimensions reveal interesting information about the organizational structure, communication forms and organizational culture in conjunction with business processes.

Moving on again to consider how humans acquire knowledge held by other humans, there is a popular view about knowledge acquisition, which can be considered one of the main tools that the business analysts use for learning about the current situation of the business processes, that “expert’s minds are filled with nuggets of information about their specialised domains. The knowledge engineer then mines these nuggets of knowledge from the head of the expert one nugget at a time” (Anthony, T. et al., 1992). This view might not be fully complete or comprehensive, but it directed this research to try to find the answer to the following questions: how can knowledge engineers or business analysts try to mine or extract the knowledge from experts’ heads? What type of questions do they usually ask? Are there any commonalities between these questions?

By analysing different techniques, such as interviewing, workshops, questionnaires and even observational techniques, it has been concluded that almost all of them are trying to ask people to remember how they carry out their day-to-day jobs. They are actually posing different forms of the same question: “What have you been doing at time T in place P?”. It can be argued that this question is the retrieval query for episodic memory (Tulving, 1984). The term episodic memory refers to the memory of events happening in a specific place at a specific time (Hasselmo, 2011). The answers to the episodic memory retrieval queries are “short time slices of experience with beginning and end points often related to achievement of a specific goal” (Conoway, 2009). What does this sentence bring to mind in the context of business processes, or, in other words, what are the short time slices of experience with beginnings and end points related to achievement of a specific goal? This paper argues that each is the definition of a fragment of a business process instance. It is a process because it has a beginning and an end, it shows what happens from the beginning to the end, and it is related to achieving a specific goal; and it is “process instance” because it is an experience and it is not abstract; and, finally, it is a “fragment” of the business process instance because it is a short time slice experience.

And it seems that because the question is usually asked in a generalised form, “What do you do in your day-to-day job?”, respondents’ minds process the outcomes of their episodic memory and create a more generalised answer. It means they remember several fragments of business process instances, try to find similar patterns between them, turn them into a more holistic process and describe it in an abstract way.

The next step in the process of developing the dependency cycle concept involves finding where to look for the fragments of business process instances, or, in other words, finding where the source of information that the fragments of business process instances model can be extracted from, the source of information that is more reliable than human memory and at the same time has been generated by humans. Conversation for Action theory was examined at this point. Winograd et al. (1987) believe that business processes are networks of conversation for action that are happening in the organisation around the organisational goals. The theory suggested that the source of information should be a history of organisational communication, or, in other words, conversation logs. Fragments of business process instances can be found inside those communications and interactions that have happened to achieve the organisational goals. Winograd et al. (1987) have introduced the conversation for action diagram (see figure 2). The authors believe that this is a good starting place for extracting the networks of conversations from any type of conversation logs.

Winograd et al. (1987) also believe that organisations are networks of commitments. This idea is quite inline with the i* framework that has been built around the intentional, strategic, autonomous actor, that in relationship with other actors, by considering different “dependency configurations”, fulfils its goals and responsibilities (Yu, 2010). These two definitions, in conjunction with episodic memory and conversation for action theory, led us to create the concept of dependency cycles. Dependency cycles show how different organisational roles depend on each other to fulfill an organisational objective. The dependency cycles represent fragments of business process instances as they follow the conversation for action diagram states. They show how people converse, and, in conversing, depend on each other to fulfill an objective.
2.2 Extracting the Dependency Cycles from Conversation Logs and Analysing Them

In this sub-section of the paper a set of principles and heuristics will be introduced that facilitate the extraction of dependency cycles from conversation logs. These principles and heuristics are not limited to any specific conversation corpus, but a specific method has been developed based on them for email corpora. This method has been applied for the case study be discussed later.

2.2.1 Principles and Heuristics for Extracting Dependency Cycles from Conversation Logs

The following heuristics and principles can be used for extracting dependency cycles:

1. Conversations that contain some form of “request” starts a new dependency cycle. This heuristic has been put forward based on the fact that some sort of dependency is usually created when we ask someone to do something for us.

2. A dependency cycle can have one or more nested dependency cycles: to deliver a dependency’s dependum, the dependee might need to create more dependencies. For instance, the root dependency cycle might be a goal dependency between two actors. Then the dependee might create some resource dependencies to obtain the necessary resources for achieving the goal and some task dependencies to carry out some of the steps. In turn, the resource providers might have some task dependencies, and some soft goal dependencies with some other actors to create the resources in time and with certain quality.

3. Conversations containing some forms of reject, withdraw or declare concepts end a dependency cycle. These concepts show that the dependee has either delivered the dependum or has failed to provide the requested outcome.

4. The intermediary steps in a dependency cycle are similar to the intermediary steps in Conversation for Action diagram. The main point is that not all the intermediary states will be explicitly traversed. For instance, usually, after a request, the dependee fulfils the requested responsibility and goes to the assert state without explicitly promising to do the job, and the depender starts using the provided outcome without explicitly going to the declare state. The withdraw state is also complicated. Sometimes people withdraw from a dependency by just not responding. The main point here is that it can be argued that the intermediary steps are not as important as the first and last steps for a dependency cycle. As long as it can be found that a dependency cycle has started, and the sub-dependency cycles can be defined, and the dependency cycle can be finished by a result, then the intermediary steps can be ignored as it has been accepted that they will follow the pattern that is introduced in Winograd’s(1987) conversation for action diagram.

5. The sequence of dependency cycles, nested within a main dependency cycle, can be concluded from their start and finish times. The start time of a dependency cycle is when a request has been made and, interestingly, the end time of the dependency cycle for this specific purpose is when the result has been asserted by dependee (not declared by depender), or the dependee has withdrawn or rejected to provide the dependum. It can even be inferred that dependency cycles, which have time overlap, can be considered parallel.

Dependency cycles can be modelled using BPMN choreography diagrams (Briol, P., 2010) (see figure 3). The focus of these diagrams is on the messages that are being exchanged between participants. The created diagrams have two dimensions. One that shows the sequence of choreography tasks and sub-choreographies and one that shows the way people depend on each other two carry out their tasks.
Figure 3 shows how a number of people have interacted (depended on each other) over selecting a supplier for a software development project. It shows Mr. M has initiated a resource dependency cycle with Mr. J. for a quote, he also has initiated a resource dependency cycle with Mr. S in parallel. In the Joining gateway we have either quote 1, quote 2 or both (depending on the dependency cycle closure – if the dependum has been delivered or not). After that, Mr. M has initiated a goal dependency cycle with Mr. D to assess the quotes and select the preferred supplier. This diagram is only showing one dimension of the dependency cycle model which is their sequence to achieve the objective of the process which is selecting a supplier. The other dimension is the nested dependency cycles for each of the initiated dependency cycles. For instance, for the last dependum which is “selected supplier based on quotes” and is initiated by Mr. M, Mr. D might start initiating several other dependency cycles to deliver the dependum.

2.2.2 Dependency Cycles’ Patterns and How They Can be Analyzed

Apart from business processes, dependency cycles demonstrate a dependency pattern between different project roles. This dependency pattern can reveal a lot of valuable information about team culture, suitability of assigned roles and responsibilities, and communication patterns. Analyzing successful and unsuccessful projects and teams, and extracting their dependency cycle patterns and reflecting on them may help to identify future project problems identified by referring to those extracted patterns.

The following scenario clarifies what the dependency cycle patterns are, how they can be analysed and how they can help us find organisational and communication problems with the project team. The project team and their roles and responsibilities will be introduced first; then, what the expected dependency patterns are, based on several successful projects that have had similar team configuration, will be argued.

A project team has been built to develop a product that consists of two main sub-products: a physical book series and a software system that enables the readers to read the book online and communicate about the book content. This project team includes:

1. Product manager: the owner of the whole product idea (usually a very senior person in the publishing team).
2. Product owner: responsible for ensuring that the product that is being built is in line with the product owner’s idea. The product manager is usually more involved with the day-to-day project and monitors the product development progress.
3. Non-technical project manager: responsible for the overall management of the project from physical book publishing to developing the supporting software.
4. Technical project manager: responsible for managing the software development team and the software development sub-project.
5. Editors
6. Developers and testers
7. Graphic designers
8. Suppliers: responsible for supplying any type of necessary goods for performing the project tasks.

Let us consider what we would usually expect the dependency cycle patterns to be for this specific scenario and context and then discuss what the anomalies can disclose. What is being introduced as an expected dependency pattern has been concluded from the experience of a number of successful projects, but it is not meant to be definitive at all. More patterns should be extracted from successful and unsuccessful projects to ascertain the degree of support for this preliminary idea.

The product manager is a senior publisher who has a very high level idea about what the product should be and what features and functionalities it should have, so he usually has a number of high level goals and objectives about the product that he would like to achieve. The product manager usually communicates with product owners and delegates the responsibility of the development of a specific product to the product owner by defining the high-level goals and objectives. Naturally we expect product managers to initiate a lot of goal dependency cycles specifically with product owners to make them aware of their expectation about the to-be built product.

Product owners are publishers as well. Based on what they have understood from the product manager’s expectations, they try to keep the developing product close to the image they have got from the product manager in their mind. As product owners are not usually technical, they have a high level understanding of the product features and functionalities, but they are more involved with the day-to-day activities of the project. At this level of management we still expect a lot of initiated goal dependency cycles between the product owner and project management team and a number of soft goal dependency cycles that define the high level quality of the product.

The non-technical project manager is responsible for managing the publishing part of the project and also liaises between the software development and publishing teams if any communication is necessary. So we expect a lot of initiated task dependency cycles and resource dependency cycles between the non-technical project manager and the publishing team, like authors, editors, typesetters, printers etc. As the technical project manager reports the progress of the development side to the non-technical project manager, we expect to see some initiated resource dependency cycles (reports) between non-technical project manager and technical project manager.

The technical project manager works in the same capacity as the non-technical project manager but for the software development team. So we expect a lot of initiated task dependency cycles, resource dependency cycles and also soft goal dependency cycles.

Assuming that the aforementioned dependency cycle patterns show a healthy project team (as mentioned before, based on successful project experience) any deviation from these patterns might be an alarm for some sort of problem. For instance, imagine that no resource dependency cycles have been extracted between non-technical and technical project managers. It shows that there are no communications between these two teams or there are some task dependency cycles between non-technical project manager and the development team. This might show that the technical project manager is not doing his job well and non-technical project manager is taking over his role that can be dangerous at points. People on the higher level of an organizational chart should be able to delegate tasks and create goal dependency cycles and leave the task details to the people who are doing the job. If there are people in those positions that are not able to do that, initiated dependency types vividly show that and the decision maker can find a more suitable position for them. Analyzing dependency cycle configuration can reveal interesting information about dynamics of the project team. More of these anomalies will be analyzed in the case study section with a real life scenario. The interesting point here is that the more projects that are analyzed using this technique, and the more healthy patterns that are extracted and analyzed, the easier it is likely to be for the analysts and consultants to find the problems of the future projects.

3. DEMONSTRATION (CASE STUDY)

In this section, a case study will be introduced in which the proposed technique has been successfully used to find out some of the organizational problems with the project team. The simple expected-dependency cycle patterns that were introduced in the previous section were extracted by applying the proposed technique to two successful projects within the same company and same context.
The project under investigation had the exact same configuration and team setup as the hypothetical team that was described in subsection 2.2.2. The team had realized that they hadn’t been working up to their potentials. Deadlines were getting missed, the product owner was not completely happy with the outcomes of the project and the team morale was very low in general. So we were invited to investigate the problem and see what we could find to help the team to perform better. In addition to other conventional methods like counseling and observation, we applied the proposed technique and produced results that were not obtainable using other techniques.

Email messages were used as conversation logs. In the first step, all the email messages that were related to the project under investigation were captured and irrelevant emails were filtered out. Then using the proposed technique’s principles and heuristics, the dependency cycles were extracted and modeled using BPMN 2.0 choreography diagrams. Apart from analyzing those choreography diagrams that were instances of some of the business process fragments and finding some optimization solution to the processes they were executing, the following anomalies were discovered in the configuration of the dependency cycles. The base of comparison to detect the anomalies were those expected-dependency cycles that were discussed in the previous section (due to privacy issues the exact figures cannot be revealed):

1. A large number of “task dependency cycles” between product owner and project managers (both technical and non-technical)
2. A large number of “resource dependency cycles” between product owner and the rest of the team
3. No “soft-goal dependency cycles” extracted
4. Small number of (any type of) dependency cycles between non-technical project manager and the technical project manager.

The first interesting detected anomaly was a large number of “task dependency cycles” between product owner and project managers. Due to the role that a product owner plays in the team, more goal dependency cycles and soft-goal dependency cycles (expected quality or non functional requirements) were expected. The product owner is responsible for conveying the high level image of the product to the project team and making sure that what is being built is in line with that image. Too many task dependency cycles could be an indication of one of the following causes:

• A company culture that expect the product owner to have full control over the project, which causes a lot of problems as product owners are not necessarily good project managers.
• The personality of a product owner who would like to have full control over every single task that is being done.
• A trust issue which shows the product owner does not specifically believe in the capabilities of the project managers
• Actual lack of capability of the project managers that makes the product owner to play their roles as well.

The second interesting anomaly detected was a large number of resource dependency cycles between the product owner and the rest of the team. The product owner was asking everyone to report to her and the project managers were bypassed. This anomaly could be quite inter-related to the previous one: any of the aforementioned causes for the first anomaly could cause the second one as well. Another specific cause for this anomaly could be badly designed communication channels that again could be a sign of bad project management.

No soft-goal dependency cycle was the third anomaly found. This could be a sign of lack of communication about expected product and project qualities, which, in the end, could cause dissatisfaction for the product owner. In the product level it could again be related to some of the first causes but in the project level it is usually caused by a bad project management practice.

Although the non-technical project manager was responsible for relaying the development progress reports to the product owner, a very small number of dependency cycles had been initiated between non-technical and technical project managers. It could be an indication of lack of communication between these two team members that in turn had caused the product owner to have a very limited understanding of the software product that was being developed and making her to directly ask for reports from the development team.

After analyzing the findings, they were shared with the team and discussed. It was concluded from the findings and consultation that the following list could be the main causes of some of the project problems:
• The personality of a product owner who would like to be involved in every detail of the project and could not delegate the tasks.
• A poorly communicated high level image of the product
• Poorly defined and communicated non-functional requirements of the product that had caused dissatisfaction of the product owner that had caused her to lose trust in the development team.
• A badly designed communication channels.
• The incompetency of the non-technical project manager that had caused mistrust between the product owner and the project team.

4. CONCLUSION

This paper introduced a new concept called dependency cycles which has been inspired by i* framework strategic dependency model, Conversation for Action diagram and episodic memory theory. Dependency cycles can be extracted from conversation logs such as email conversations using the technique that has been introduced in the paper.

By extracting dependency cycles from successful and unsuccessful projects and analysing their structure and patterns, a model can be created that reveals a lot of information about team communication structure, process models that the project team is following, organizational cultures and even some aspect of the team member’s personality. This information can help the project team or the consultants and analysts to find the team structural problems, communication problems, bottlenecks, and bad habits in organisational culture and even optimise the processes the project team follows.

REFERENCES

MODELLING THE IMPLEMENTATION
OF AN ORGANIZATION: MAPPING ONTOLOGICAL
TRANSACTIONS INTO ACTIVITY DIAGRAMS

António Gonçalves¹, Pedro Sousa² and Marielba Zacarias³

¹Instituto Politécnico Setúbal - Rua Vale Chaves Estefanilha, - Setúbal
²Instituto Superior Algarve - Av. Rovisco Pais, I - Lisboa
³Universidade Algarve – Campus de Gambelas – Faro

ABSTRACT

Although there are several applications of Activity Theory to the study of collaborative work there is no single approach that enables to obtain the Activity diagram from Organization Ontological Business Process. This article presents a proposal of a method to obtain Activity diagrams from the business process. The proposal links ontological business transactions, described in Ψ theory developed by Dietz, and activity diagrams, proposed by Engeström, covering various components of a particular activity, participants, work rules and social tools used and goals and motives of an Activity. For validation purposes, this proposal was applied in a real case study. The result showed that the usage of Organization Ontological Business Process provides a basis for initial analysis of existing organization activities. However some aspects are not present in the Ontological Business Process, such as the tools that mediate the action of subjects with the objective activity.

KEYWORDS

Activity Theory, Ontological Business Process, Transaction

1. INTRODUCTION AND PROBLEM DESCRIPTION

Organization modelling techniques tend to classify organization as a set of structured artefacts (UML (Jansen et al. 2003), ArchiMate (Lankhorst et al. 2009) and DEMO (Dietz 2006a) ). In such models, a person is just another artefact. Consideration of persons as artefacts and disregarding their properties inhibits any of the above models from capturing people’s unique social characteristics that are known and studied in other domains, such as: organization as a soft social network (ACTIVITY THEORY, situated ACTION MODELS and DISTRIBUTED Cognition) (Rogers & Ellis 1994) (B. A. Nardi 1996). In the case of such domains, while unique characteristics of people are present, activity models are used to perform analytical analyses of organizations.

Since organizations are built and operated by people we assume that both modelling approaches are necessary and must coexist: Modelling people as an artefact intends to structure work and improve its control, enhancing the predictability of organizational activities through robust and stable models; Organization modelling based on soft social models seeks greater flexibility, especially in the context of organizational realities marked by great turbulence and rapid change, and preserving the human capacity to cope with changes, exceptions and unique contexts (Chang 2005). However, the goals of flexible and structured models are often considered not only in conflict, but even mutually exclusive (Cobb 2004).

This work proposes a solution that implies enriching an artefact-based modelling approach with social modelling by linking two models: the DEMO ontology model (structured modelling approach) (Dietz 2006a), and Activity Theory (social modelling approach) (Engeström 1987), obtaining a unified representation of an organization.

Activity theory is useful because it considers the entire human practice as a socio-historical development process that explains executed conscious and unconscious actions, as well as the tools and the socio-cultural rules applied to it. Although there are several Activity Theory applications that include works addressing the
description of work practices in an organization (Kaptelinin & B. Nardi 2006), it appears that there are no proven methods to obtain activity diagrams in an easy manner.

DEMO models human ability to produce goods or services through commitments, abstracting from the technology used, particular actions performed and people who perform these actions (called by DEMO as the Implementation Organization). For example, Dumay (Dumay 2005) states that the ontological model is not sufficiently detailed to capture human interactions and does not explain how the work done by human artefacts supported by technological artefacts contributes to achieving new business goals or improving current performance measures.

The present work aims to capture and describe activities identified in the organization ontological model, taking into account the need to achieve a balance between a structured and formal description and a less structured description of human, social and contextual concerns of activities within an organization. Our proposal will be illustrated through a case study consisting of client relations with True-Kare (www.true-kare.com), a company specialized in selling support services to seniors.

This paper is organized as follows: Section 2 presents the theoretical framework, namely the Ψ theory and the Activity theory. Section 3 describes the proposed solution, which is composed of a set of rules that can be applied to obtain the activity diagrams of transactions from an ontological model. Section 4 shows how the proposed solution is applied in a case study and finally in Section 5, the results are discussed and conclusions are drawn, including the outline of future works.

2. THEORETICAL

2.1 Activity Theory

According to the Activity Theory (Vygotskii & Cole 1978) (Veer & Valsiner 1993), developed as a result of a pioneered effort of Vygotsky, Leon't'ev and Luria, people’s work in an organization is a complex structure, which is performed by a group of individuals, acting in accordance with labour division, framed in a historical, social and cultural context.

When this activity is fragmented into smaller units, called actions, it means that each of the individual actions is a component of collective activity and may no longer have a direct affinity with the motive for the activity and shall maintain an indirect relation with that motive. This may reflect that community members (individually) can often not be aware of the motive for the activity. In this way, actions are temporary and have a clearly defined beginning and termination point, whereas an activity keeps developing over a long social time process. In other words, according to Activity Theory, the transformation of an object into a result is not instant. The results are carried through a series of conscious steps, called actions, which have well-defined goals and are time framed. These goals do not always have an instant relationship with the motive of the activity. Due to this, activities and actions are not interdependent. An activity is an arrangement of different actions and an action can belong to more than one activity. The actions can be fragmented into other actions in an interactive way. They can comprise these and other actions by other actions, and so forth.

By decomposing actions into other actions, these have more specific goals. At their lowest, actions are composed of chains of operations that are performed in an unconscious way and are dependent on the specific conditions of the context. In turn, operations depend on physical or sociocultural conditions.

Engeström (Engeström 1987) grouped several concepts from the theoretical basis of Vygotsky and Leon't'ev, which, until then, were dispersed. (Figure 1) We highlight their contribution of recognizing activity as a unit of analysis, considering that this model is the “smallest and simplest unit that still preserves the essence and integral quality behind any collective activity performed by a group of people” and introducing three other elements which previously appeared in an unclear format: the community, the social division of work and rules. Use the principle of mediation to describe the complex network of relationships of human activity. A community is composed of many individuals that perform the activity. Tools mediate the relationship between subject and object, rules mediate the relationship between subject and community and finally the division of work mediates the relationship between object and community.
2.2 Ψ Theory

According to Dietz (Dietz 2006a) (Dietz 2006b), it is not possible to achieve organizational goals without essential, systematic and comprehensive knowledge of how enterprises are built and operate.

Essential knowledge is necessary for the organization to be able to handle current and future challenges. Knowledge is described through a conceptual model of an organization, called ontological model. Dietz theory Ψ is the basis for a description of ontology of an organization; it addresses the construction and operation of the system, for example, elements, and the construction and expression of their interactions over time. This theory consists of four axioms Ψ (operation, transaction, composition and distinction) and the theorem of the organization. A complete overview of the theory and its associated methodologies is available in the book (Dietz 2006a) and Articles (Dietz & J. A. P. Hoogervorst 2008) (Dietz & Albani 2005) (Dietz & J. Hoogervorst 2007). This article will describe the social interaction that underlies Dietz theory. According to theory Ψ, people, in their social interactions, engage in actions to be taken and agree on the results of those actions (Dietz 2006a). This is done through acts of coordination, through language that can be understood as issuing a ruling seen as an action. In this case, the act is called a performative utterance of contractual character, and creating new facts or actions becomes part of an action.

By stating the act does not describe even the announcer says performing an action. Is it really performs. Performative utterances do not describe or verify something, are not true or false, are not only saying or assert, but are part of the action. In particular, the theory indicates that Ψ acts, performed by agents, always occur in universal standards, business transactions. The result of the execution of a transaction is called the creation of a fact (Dietz 2006a).

The default transaction consists of the following acts: request, commitment, delivery confirmation and coordination of actions. It features two actors, each with a distinct role: The initiator, who starts and commits the transaction and the executor, who undertakes and performs the act of production and product delivery. Figure 2 is a graphical representation of standard business transactions. Based on theory Ψ, Dietz developed a methodology called DEMO (Design and Engineering Methodology for Organizations) consisting of four models (CM, AM, PM and SM) and a method, which describes how to obtain an ontological model.
3. PROPOSED SOLUTION

Concepts present in Action Model (AM) are used for capture activity diagrams, because according to Dietz (Dietz 2006a, p.185): "the model AM is the most detailed and comprehensive of all models and all present at DEMO other models may be obtained from the model AM". Thus, it is also our belief that all the necessary information to initiate an activity template can be obtained from the interpretation of the information contained in the model AM. In the diagram, AM relates all axioms of the theory Ψ through acts of coordination (application, commitment, affirmation and acceptance, etc.) and production (supply of goods and services) of each transaction.

AM specifies business rules that serve as guidelines for the actors to deal with their agendas, containing one or more rules for each type of scheduling. Action rules are specified in AM function as guidelines for an actor to handle each scenario that will have to act. Then these rules are grouped according to the roles of each identified actor. In Figure 5 we present a concrete example of AM rule, which is associated with ontological modelling of a tennis club, described in (Dietz 2006a, p.26).

| When T01 of new [MEMBER] is requested |
| If age (MEMBER) > minimal_age |
| and #Members (Volley) < maximum_number (current_year) |

The proposed solution, which leads to a conception of Activity diagrams, is a set of rules that guideline the mapping of initial concepts in the Ψ theory on the basis of the concepts present in the Activity theory. The rules are expressed below:

- Rule R1 (Identification of Activities): Every Ontological Transaction is mapped to an activity diagram where the result of the Transaction is accepting the fact of production;
- Rule R2 (Operational Rating of Activity Actions): Actions goals are mapped to achieve the results of B-Organization, materializing into Coordination and Production facts;
- Rule R3 (Classification of Operations): Operations are procedures associated with production acts of an Enterprise’s I-Organization and D-Organization, as information of I-Organization and form aspects of D-Organization;
- Rule R4 (Life Cycle of an Activity): In Activity, actions are organized according to transaction pattern phases (O-Phase, E-Phase and R-Phase);
- Rule R5 (Subjects and Community): The Actor who initiates a transaction is mapped on the subject of the activity and the rest is part of the Community.
These rules aim to interpret the access to information in the original facts and derivatives as well as actions and operations, associated with acts of coordination and production. The result is the identification for each activity of actions, operations, subject community and its articulation. The use of rules promotes sharing explicit and tacit knowledge that each individual possesses and which is usually difficult to be formalized or explained to others, because it is subjective and is an inherent ability of a person.

4. CASE STUDY

The TRUE-KARE company has developed a service platform that facilitates the support given by family or institutions to senior people or people with some level of dependence.

The main components of this service are, a mobile phone, used as an interface for the person who is being supported, and a WebSelfCare portal, which serves as the interface for the person who is supporting. WebSelfCare portal permits to have full control of the service and to monitor remotely all of the phone’s features, under the condition that the device is connected to the Internet. With this service, caregivers can monitor and provide a continuous support to those, who are receiving care, wherever they are. The marketing and the use of the service involve a multiplicity of components. In this case study, mobile equipment purchase and service activation online components will be considered.

4.1 Ontological Model

Table 1 describes the business Transaction of true-Kare.

<table>
<thead>
<tr>
<th>T#</th>
<th>Transaction</th>
<th>R#</th>
<th>Result (fact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-T01</td>
<td>Equipment Order</td>
<td>R-R01</td>
<td>[EQUIPMENT] has been Ordered</td>
</tr>
<tr>
<td>B-T02</td>
<td>Equipment Payment</td>
<td>R-R02</td>
<td>[EQUIPMENT] has been Paid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-T08</td>
<td>Stock Control</td>
<td>R-R08</td>
<td>Equipment Stock Control for Day [DAY] has been done</td>
</tr>
</tbody>
</table>

Figure 3. Global ATD of True-Kare
4.2 Mapping Ontological Transactions into Activities

4.2.1 Identification of Activities

At an initial phase, called observation, TRT table and the Global ATD chart of TRUE-KARE is analysed. Applying rule R1 (Every Ontological Transaction is mapped in an Activity diagram), Activities are identified (Table 2).

Table 2. Activities Identification

<table>
<thead>
<tr>
<th>NAME</th>
<th>OBJECT</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Order</td>
<td>EQUIPMENT</td>
<td>[EQUIPMENT] is Ordered</td>
</tr>
<tr>
<td>Equipment Payment</td>
<td>EQUIPMENT</td>
<td>[EQUIPMENT] has been Paid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.2 Operational Classification of Actions and Life Cycle of an Activity

At this stage, called orientation, each of the previously identified activities is detailed. For each activity, actions, its operations and its connection to the life cycle of an activity is identified. To achieve this, the rules R2, R3, R4 and R5 are applied. As example (table 3) we present the results obtained from the analysis of an activity "Equipment Order Phase-O".

Table 3. Activity: Equipment order: Phase:-O

<table>
<thead>
<tr>
<th>AGENDA</th>
<th>SUBJECT</th>
<th>GOAL B-ORGANIZATION</th>
<th>GOAL 1- ORGANIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>T01 REQUEST</td>
<td>True-Kare equipment Controller</td>
<td>(1) REPRODUZE [CLIENT]</td>
<td>(1) IF (1) AND (2) AND (3)</td>
</tr>
<tr>
<td></td>
<td>True-Kare equipment Controller</td>
<td>(2) REPRODUZE [EQUIPMENT]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>True-Kare equipment Controller</td>
<td>(3) CALCULATE</td>
<td>#[EQUIPMENT] &lt;= STOCK (equipment)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>True-Kare equipment Controller</td>
<td>IF NOT DECLINE [EQUIPMENT]</td>
<td>REEMEMBER DECLINE [EQUIPMENT] ORDER</td>
</tr>
</tbody>
</table>

4.2.3 Identification of Actions, Operations and Conditions of Activity

Table 4. Activity Actions and Operations

<table>
<thead>
<tr>
<th>ACTION</th>
<th>OPERATION</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Order Promising</td>
<td>Get customer data</td>
<td>Have available client Fact Sheet</td>
</tr>
<tr>
<td></td>
<td>Get order data</td>
<td>Have available equipment Fact Sheet</td>
</tr>
<tr>
<td></td>
<td>Calculate stock equipment</td>
<td>Have access to stock</td>
</tr>
<tr>
<td></td>
<td>Inform the customer promise of delivery of the order</td>
<td>Have available means of communication with customer</td>
</tr>
<tr>
<td></td>
<td>Register order delivery promise</td>
<td>Have access to available written in the register of orders</td>
</tr>
<tr>
<td>Reject Order Customer</td>
<td>Get order data</td>
<td>Reading access to orders</td>
</tr>
<tr>
<td></td>
<td>Inform the customer's rejection of order delivery promise</td>
<td>Have available means of communication with customer</td>
</tr>
<tr>
<td></td>
<td>Register rejection delivery order</td>
<td>Writing access to orders</td>
</tr>
</tbody>
</table>
5. CONCLUSION

This article discussed an approach to describe activities from ontological transactions, based on theory $\Psi$ and methodology DEMO, as a response to the problem of modelling the implementation of an organization. For such, we adopted a set of rules for transforming Ontological Transactions in Activity Theory Diagrams. The aim is to have a baseline of a collective work of people through the concepts present in Engeström diagrams, obtained from information contained in the model Action Model (AM) and presented in the DEMO methodology. The use of DEMO had the following benefits: 1) Delimit the area of operation of an organization through the concepts of components, environment and structure. The components are people, playing actors roles, with the ability to interact in getting commitments will be enforced, the environment consists of people within the same category, which may or may not be contained in an organization, but who act or are conditioned by them, finally the structure of an organization is a set of relations that mutually influence people’s behaviour within an organization and identify outliers, who are directly related to those belonging to the organization; 2) Regarding Business Processes Transactions, described in the ontological model and model AM, it is easier to identify actors in the dimension of implementation (model Activities), identifying those, who initiate and accept a request and those, who execute and deliver a service or one product.

Using DEMO diagrams becomes more difficult when it is intended to describe actions and operations of the Activity Diagram, because DEMO applies the same standard of communication to different aspects of human skills in an organization (in negotiation, information management and aspects related to the transportation, storage and retrieval of data). The solution lies in mapping different human abilities, proposed by Dietz (Dietz, 2006a, p. 116) to actions and operations, following the proposed policy: 1) The ability to negotiate is associated with actions and 2) The ability to manager information and documents are associated with operations. This mapping leads to the assumption that, by the purpose innate in the Activity theory, negotiation skills are always performed in a conscious way and that information management skills and data, although at an early stage, can be performed in a conscious way. However, over time, these skills become unconsciously performed in a manner dependent of existing conditions. DEMO does not model two components, important in defining an activity: Technological tools and behavior social rules.

As a conclusion, we can state that defining the activities from the Ontological model provides a basis for an initial analysis of people’s practices within an organization. However, some aspects are not present at DEMO model, including the tools that mediate the action of subjects with the objective activity.

In future work, the expression of the social rules on the ontological AM model and the interpretation of the expansive learning cycle of activity theory, will be analysed, as a mode of construction and resolution of tensions and contradictions in an organization. We intend to use the DEMO methodology approach to analyse the impact of the analysis of contradictions.

REFERENCES


IT OPERATIONAL RISK MANAGEMENT PRACTICES
IN AUSTRIAN BANKS: PRELIMINARY RESULTS
FROM EXPLORATORY CASE STUDIES

Stefan Bauer and Edward W. N. Bernroider
Vienna University of Economics and Business

ABSTRACT
The aim of this research is to discover practical insights and suitable methods to effectively manage IT operational risk in Austrian banking companies. We applied an exploratory case study approach and data were conducted using semi-structured face-to-face interviews with senior risk managers. The findings further improve our understanding of how operational risk departments are structured, how employee awareness of IT operational risk loss events is fostered, and the use of operational risk measurement approaches. Moreover, we shed light on practical implementation issues of internal controls in the business and IT processes.

KEYWORDS

1. INTRODUCTION
The flood of new regulation in the last decade and high impact operational loss events increase interest in operation risk management in banking companies (Bauer, 2012). Recent IT operational loss events such as information security breaches or software update failures in banks from all over the world substantiate the problematic situation (Goldstein, Chernobai, & Benaroch, 2011). The recent loss event of an estimated £100 million of the Royal Bank of Scotland in June 2012 due to a software update failure is further evidence for the significance of IT risks (Treanor, 2012). Moreover, banking companies are forced to be compliant to the Basel II regulation which obligates the banking companies to manage operational risks (Basel Committee on Banking Supervision, 2004a; Luthy & Forcht, 2006). Banking companies face several problems with the management of operational risks, especially in connection with IT (Oh, Phua, & Teo, 2007).

As major IT related operational loss events demonstrate, the operational continuity of banking services are threatened by IT problems and banks need to enforce risk management to mitigate these loss events (Oh et al., 2007). For banks, IT is a critical success factor for their daily business and for their projects (Svatá & Fleischmann, 2011). The ever-increasing IT complexity exposes the banking organization to a range of vulnerabilities and a wide spectrum of threats. Over all industries, the banking and financial services sector has the highest actual IT budget as percent of revenue (6.0%) in 2010 (Potter, Smith, Guevara, Hall, & Stegman, 2011).

Efficient and effective IT operational risk management is a constituent element of IT governance (Novotny, Bernroider, & Koch, 2012) and essential for banks not only due to their IT intensive business, but also to balance minimum capital requirements and further capital buffers. The more minimum capital is requirement, the less money banks can use for generating profits (Jobst, 2007a). Given an effective operational risk management, banks have to put back less capital to safeguard their organization and comply with Basel regulations.

The aim of this article is to discover effective and efficient IT operational risk management practices of banking companies in Austria. The motivation for this article resulted from the perceived gap in the literature concerning current practices in IT operational risk management in the midst of the current financial sector crises. The underlying research explores practical problems of IT operational risk management and identifies
fields for further research. An exploratory case study approach was used to explore the research topic (Benbasat, Goldstein, & Mead, 1987a). Several semi structured face-to-face interviews in Austrian banks were conducted to answer the research questions. Because of the exploratory nature of this paper, new areas of interest were detected and analyzed through the research process. Our findings highlight current practice about building awareness of the employees regarding IT risks, establishing effective internal controls for IT operational loss events and IT operational risk management in general.

This paper has been divided into six sections. The paper begins by briefly describing the purpose of the underlying research. Section two then moves on to consider the literature review and the theoretical background. Section three offers the research method and methodology. Section four provides an aggregation of the results. Section 5 goes on to discuss the results in the context of the research questions. In the concluding section, we also clarify limitations of the research and offer links for further research.

2. LITERATURE REVIEW AND RESEARCH MOTIVATION

The underlying research paper focuses on practical insights and effective methods to manage IT operational risk. This chapter deals with structural and measurement issues of operational risk, IT operational risk awareness of employees, IT risk management frameworks and with the research objectives. The literature review should explain important terms and concepts and conduct to the research questions.

2.1 Structural and Measurement Issues

Operational risk is defined by the Basel Committee as, “the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk” (Basel Committee on Banking Supervision, 2004b). The Basel Committee (2004) defined seven different loss types. Each of these loss types could have an influence on the function of IT assets or on data, hence each loss type is important for IT operational risk (Goldstein et al., 2011). Goldstein at al. define IT operational risk as "any threat to the integrity, confidentiality, or availability of data assets or IT assets that create, process, transport and store data" (Goldstein et al., 2011). IT operational risks are managed in a cause-effect relationship and they are strongly interdependent with other risks (Supatgiat, Kenyon, & Heusler, 2006).

There are three different possibilities to calculate the minimum capital requirements for operational risk: the Basic Indicator Approach, the Standardized Approach and the Advanced Measurement Approach (Jobst, 2007b; Wahlström, 2006). In 2011 the consulting firm Deloitte asked 131 financial companies worldwide concerning their operational risk management approach (Hida, 2011). Only 15% of the financial service companies worldwide use the Advanced Measurement Approach (AMA) to calculate the minimum capital requirements for operational risk. 40% of the financial service companies use the Standardized Approach (SA) and 45% still calculate their requirements through the Basic Indicator Approach (BIA) (Hida, 2011). The selection of the measurement approach impacts the reporting of IT operational risk, because the AMA requires the banks to collect internal loss data on a high level (Jobst, 2007b). In this context, incentives for employees or business entities to disclose weaknesses and loss events are an interesting and prospective topic for banks (Acharyya & Johnson, 2006).

A recent literature review gives an overview of current work about operational risk in banking companies (Benaroch, Chernobai, & Goldstein, 2012; Goldstein et al., 2011). Banks share their loss data with other banks in external databases. The Operational Riskdata eXchange Association (ORX) database collects data from 62 banking groups worldwide and they reported 27,053 individual loss events with a total gross loss of €9,110 billion in the year 2009 (ORX Association, 2012).

2.2 IT Operational Risk Awareness

At this point it is appropriate to consider the importance and influence of the Basel II regulation for the IT risk culture of banking companies (Jahner & Krcmar, 2005). If banking companies are Basel II compliant, they have to build awareness of their employees concerning IT operational risks (Basel Committee on Banking Supervision, 2004b). The generic nature of the Basel II regulation in this point is a problem for
banking companies, because they have only little guidance on the practical implementation of awareness building actions and therefore they are free to select methods (Fox et al., 2011). Hence, it seems important to discover different awareness building practices in banking companies.

Banking companies have to complaint with Basel II and soon with Basel III, and therefore they need to implement internal controls to monitor key risks (IT Governance Institute, 2007). The Institute of Operational Risk define indicators as "metrics used to monitor identified risk exposures over time" (Institute of Operational Risk, 2010). Internal control helps organizations that they reach their compliance goals (IT Governance Institute, 2007). Banks often implement internal controls through key performance or risk indicators in their processes and they can use software tools to monitor the indicators (Wiesche, Berwing, Schermann, & Krcmar, 2011). Further there is the possibility that incentive schemes motivate employees to report IT operational risk events in time and in a good quality (Lin, Guan, & Fang, 2010; Moynihan & Wells, 2010). Banking companies use key risk indicators extracted from the CobiT framework to monitor IT risks (Benaroch & Chernobai, 2012; IT Governance Institute, 2007).

2.3 IT Risk Management Frameworks

Banks can revert to use best practice control frameworks to satisfy auditors, IT managers and consultants and manage the IT related risks in the organization. One well established control framework is the Control Objectives for IT and related Technology (CobiT) framework (ISACA, 2008) which is extensively used to control IT related strategies and operations and to support legal compliance with regulative requirements such as those from the Sarbanes Oxley Act or Basel 2 (Hardy, 2006; Kordel, 2004). While the CobiT framework seems to be widely used in practice, academic validity and internal consistency research on CobiT elements is only emerging (Bernroider & Ivanov, 2011; Tuttle & Vandervelde, 2007).

2.4 Research Objectives

The above discussion has shown that failure to account for operational risk management has adverse legal and business related implications for banking companies, especially in the light of new upcoming regulations due to the current financial crisis. Furthermore, the significant role of IT in such organizations has been repeatedly identified as source of operational loss events. In accordance with the above key areas, we now define three research questions:

1. How do large Austrian banks define, structure and measure operational risks with a view on Basel II/III approaches (a), loss event databases (b), operational risk domains (c)?
2. How do large Austrian banks build awareness of IT operational risk events among their employees?
3. Which frameworks do Austrian banks use to support the design and implementation of their internal IT control systems?

The next section describes how we attempted to answer these questions.

3. RESEARCH METHODOLOGY

A case study approach was used to explore the research topic (Benbasat, Goldstein, & Mead, 1987b). Qualitative Interviews were conducted to investigate the research questions regarding IT operational risk management in Austrian banks. The authors carried out an information-oriented selection of the cases (Flyvbjerg, 2011). Figure 1 describes the whole research process.
At first, an exploratory interview with a banking auditor was carried out to determine which topics and questions could be of practical interest. The outcome of this interview was, that only several big banks in Austria manage IT operational risk professionally. The medium and small banks do not have IT operational risk departments. Therefore the authors selected respondents through the snowball technique and through online social network search. Two respondents were found through the online social networks Xing and LinkedIn. Data were gathered in the period from August to October 2012. Table 1 indicates the position of the employees, the interview types and dates. The interviewer prepared himself by reading the annual report of the banking company before the interview. As a result of this preparation, the semi-structured interviews were individualized depending on the operational risk management conducted in the respective banking company.

<table>
<thead>
<tr>
<th>Case</th>
<th>Position of interviewee</th>
<th>Type</th>
<th>Dates</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Head of Operational Risk Management</td>
<td>Face-to-Face Interview</td>
<td>3/9/12</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>Operational Risk and Risk Integration (Head)</td>
<td>Face-to-Face Interview</td>
<td>7/9/12</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Head of Group Operational Risk</td>
<td>Face-to-Face Interview</td>
<td>19/9/12</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>Head of Group OpRisk Control</td>
<td>Face-to-Face Interview</td>
<td>5/10/12</td>
<td>45</td>
</tr>
</tbody>
</table>

4. DISCUSSION OF MAIN RESULTS

Table 2 offers an overview of the main outcomes of the interviews structured along our research questions. Based on this overview we subsequently discuss each research question.
Table 2. Main results from four Austrian large banks along research questions

<table>
<thead>
<tr>
<th>Qu.</th>
<th>Area</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Degree of centralization</td>
<td>Central OpRisk departments divided into qualitative and quantitative units, DORMs in single business units</td>
<td>SA</td>
<td>AMA</td>
<td>AMA</td>
</tr>
<tr>
<td></td>
<td>ORM approach (Basel II)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b</td>
<td>Internal loss event database in use</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>External loss event database in use</td>
<td>ORX</td>
<td>ORX</td>
<td>ORX</td>
<td>No</td>
</tr>
<tr>
<td>1c</td>
<td>Reported OpRisk domains</td>
<td>1. External fraud</td>
<td>1. Execution, delivery and process management;</td>
<td>1. Execution, delivery and process management</td>
<td>1. External fraud</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Clients, products and business practices</td>
<td>2. Clients, products and business practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Main methods for awareness building</td>
<td>E-Learning for all and in-house workshops for DORMs</td>
<td>In-house training, meetings, risk maps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incentives for OpRisk event reporting</td>
<td>Monetary rewards</td>
<td>Punishment (if not reported)</td>
<td>No rewards</td>
<td>No rewards</td>
</tr>
<tr>
<td>3</td>
<td>IT risk frameworks in use</td>
<td>Modified COSO, COBIT</td>
<td>COSO, COBIT</td>
<td>COSO, COBIT</td>
<td>COSO, COBIT</td>
</tr>
<tr>
<td></td>
<td>Minimum capital requirements §22 (BWG, 2011)</td>
<td>€ 792 million</td>
<td>€ 951 million</td>
<td>€ 897 million</td>
<td>€ 144 million</td>
</tr>
<tr>
<td></td>
<td>Impact of Basel III on OpRisk management</td>
<td>Unknown</td>
<td>Small impact seen</td>
<td>Small impact seen</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

4.1 Structural and Measurement Issues (Question 1)

First of all (Q1), Austrian banks define and interpret the nature of operational risk in almost the same manner as the Basel Committee (2004). This definition is acknowledged due to the obligatory character of Basel II regulation, which will not change with the enactment of Basel III. In a socio-technical view, Austrian banks focus on loss events that can arise from internal processes (including IT processes), people and systems. In terms of structure, all cases manage operational risk centralized on the entire banking group level, but they also installed decentralized operational risk managers (DORMs) in single business units. The central operational risk management departments are divided in qualitative operational risk management and quantitative operational risk management units. The proportion of the economic risk capital is similar in all researched banks. Credit risk is the most important risk type with a share of approximately 80% of the economic risk capital. Operational risk is covered with nearly 10% and is on the same level as market risk. However, two interviewees pointed out that managing operational risk is at present more important than market risk.

In terms of Basel II measurement approaches (Q1a), only two out of the four large banks use the AMA. One interviewee noted that approximately 50% of the ORX participants calculate their minimum capital requirements with the AMA. The respondent also mentioned a tendency among the ORX participants to strive towards the AMA. However, within the AMA there are differences in calculating the minimum capital requirements. The factors are similar but the weights for the factors differ. One respondent mentioned that for the calculation 33% of the data is fetched from their internal loss database, 33% from an external database and 33% from scenarios and indicators. The selection of the measurement method for calculating the minimum capital requirements are of great interest for banking companies. The respondents mentioned advantages as well as disadvantages for using AMA. The advantages reach from reputation gains to
improved financial aspects such as the allowance of insurances due to lower minimum capital requirements. Mentioned disadvantages include the outcome. In previous years the gross income of some banks decreased, and as a consequence using AMA instead of the SA results in higher minimum capital requirements. An explanation is that lower levels of gross income per business line impacts the end results in the SA. Another interviewee declared that all banking groups in Austria besides the biggest four are not big enough to implement AMA simply because they cannot accumulate enough loss events to reasonably operate their internal data base.

With regard to loss event processing (Q1b), all four respondents noted that they work with an external and international internal loss events database. The quantitative operational risk management units are responsible for maintaining the internal loss event data base and calculating the minimum capital requirements in all four cases. However, there are also important differences across the cases. Two different loss event collection approaches can be distinguished:

1. **Centralized approach**: Central collection and uploading of operational loss events to an internal database.
2. **Decentralized approach**: Operational loss events are reported bottom-up and directly fed into the internal database by the employees.

Our findings show that banks, which use the AMA, are more likely to report operational risk events centrally. In contrast, banks not using the AMA are more likely to let their employees directly report operational risk events to their internal databases.

In all researched banks the operational risk department works together with the internal audit, compliance, law and insurance department, to manage operational risks effectively. The operational risk controlling unit is separated from operational risk management. Operational risk is for all four researched banks an important area for the future, therefore two of the four banking companies plan to hire staff for operational risk management.

### 4.2 Operational IT Risk Awareness (Question 2)

In terms of risk awareness management, all four banking companies use their qualitative operational risk management units to foster risk awareness and develop a risk culture in their organization. The regulation Basel II forces the banks to build awareness of their employees concerning operational risk. Therefore the banking companies all apply awareness building approaches, but use different methods. Three have implemented an obligatory e-Learning system to educate their employees. All respondents reported that operational risk trainings for a specific group of employees was implemented. Especially the employees with responsibilities concerning operational risk reporting (e.g. the DORMs) were trained. In all banks risk and control self assessments and risk meeting were conducted. The outcomes of the self assessments and the expert questionnaires are discussed with line management and the results reported to the central operational risk management unit. In the business lines risk meetings were hold from time to time.

Only one bank connects the quality of the reporting of operational risk events with the compensation of the managers. The managers of this bank were compensated on the base of the economic capital, which bases on risk ratios. A ratio could be how much time is needed from the detection to the reporting of operational risk event. This practice in one bank increases transparency, and helps to monitor and control operational risk management.

### 4.3 IT Risk Management Frameworks (Question 3)

Three respondents use the COSO risk management framework. One interviewee criticized that COSO forces banks to think of phantom risk with high frequency and high severity risks. The same interviewee mentioned that such risks do not exist and because of that COSO could misdirect risk management. Previous research has paid attention to this problematic (Mestchian, Makarov, & Mirzai, 2005). The dominance of COBIT as risk management framework was confirmed by the three out of four cases. The maturity levels of the frameworks are also important for the IT operational risk management, because the level of internal control belongs to maturity level of COBIT and ITIL. IT operational risk management is seen as a continuous improvement process.
All four respondents explained that they monitor operational risk through automated internal controls in their business and IT processes. The banking companies have modelled their processes and implemented key risk indicators. One respondent said that they use similar controls as the Institute for Operational Risk (2010) published in their latest article. The following key risk indicators are used (Institute of Operational Risk, 2010):

- Staff turnover: connected to risks such as fraud, staff shortages and process errors
- The number of data capture errors: process errors
- Number of virus or phishing attacks: IT systems failure
- Percentage of staff not completed primary fraud detection training
- Information technology support requests - number outstanding beyond threshold
- Project Management: number of high-risk projects

As described above, one banking company connects incentives for managers to the quality of reporting and managing operational risk events. Similar to the results of the ORX database, the respondents answered that retail banking is the most important area for operational risk management. One interviewee also mentioned that trading is very crucial, because an operational loss event there could have a huge impact. For cases the importance of an economic approach where the costs of a control do not outweigh its benefits was noted. There seems to be a level of tolerable uncertainty for high frequency and low impact events.

5. CONCLUSION AND LIMITATIONS

More sophisticated methods are needed to discover the effectiveness of incentives for managers on the basis of the economic capital. The respondent mentioned that this incentive system works well and that there is a tendency to compensate managers on risk ratios. Other respondents mentioned that they do not think an incentive system regarding operation risk management make sense. Further research should investigate how the quality of reporting operational risk differs between a bank with and a bank without an incentive system.

Additional research would be necessary to assess the risk culture and the awareness concerning operational risk loss events of the employees in the banking companies. The researched banks force an open risk communication. They use different qualitative methods to reach this goal. Awareness could prevent operational loss events and educate the employees concerning the reporting of operational IT loss events. It seems to be logical that the more employees are educated concerning operational risk, the more the quality of the reporting increase.

An interesting research question concerns E-Learning as a tool for awareness building in banking companies. E-Learning is a popular tool and in two banking companies the employees have to pass an exam after the E-Learning program at the beginning of their engagement. Additional research would be necessary to confirm that the employees are really aware concerning operational risk events after successfully passed an E-Learning program. Further research might concentrate on a comparison of the of the cost-benefit ratio of awareness building provisions, like E-Learning, risk meetings, marketing goodies.

Finally, we acknowledge several limitations. First, only big banks in Austria have an operational risk management unit. Hence, the underlying research is only relevant for this group of banks. Future research is going to focus also on medium and small banks. Second, only the senior managers on the top of the hierarchy of operational risk management were interviewed. They have had a good overview knowledge and therefore sufficed for the general aims of this paper. However, only two of them have worked before in a IT department and therefore only two respondents were able to refer to their own working experiences in terms of IT operational risk.
REFERENCES

Book
IT Governance Institute. (2007). IT Control Objectives for Basel II.

Journal

Conference paper or contributed volume


Newspaper Article

A FUZZY EXTENSION OF MAGERIT METHODOLOGY FOR RISK ANALYSIS IN INFORMATION SYSTEMS

Eloy Vicente, Antonio Jiménez and Alfonso Mateos
Departamento de Inteligencia Artificial, Facultad de Informática, Universidad Politécnica de Madrid
Campus de Montegancedo S/N, Boadilla del Monte 28660, Madrid, SPAIN

ABSTRACT
We propose a fuzzy approach to deal with risk analysis for information systems. We extend MAGERIT methodology that valuates the asset dependencies to a fuzzy framework adding fuzzy linguistic terms to valuate the different elements (terminal asset values, asset dependencies as well as the probability of threats and the resulting asset degradation) in risk analysis. Computations are based on the trapezoidal fuzzy numbers associated with these linguistic terms and, finally, the results of these operations are translated into a linguistic term by means of a similarity function.

KEYWORDS
Risk analysis. Information systems. Trapezoidal fuzzy numbers.

1. INTRODUCTION

Information Systems (IS) are composed of a set of data management elements designed to provide services and benefits in areas as far a part as public administration, industrial control, the banking or geographical and weather information.

Technological developments and the universal internet access has led to an increase in system vulnerabilities, since organizations have connected ISs to corporate and even public networks that could be accessed by non-authorized personnel unless appropriate action is not taken. Besides, people within the organization have to be trained in and aware IS support technology as technology misuse can cause disastrous failures.

On top of these vulnerabilities caused by recent technological developments, there are other traditional issues, such as integrity facilities or the safeguarding of not necessarily digital documents, on which the new technologies have also had an impact. Therefore, ISs have to be analyzed with a view to risk minimization by means of well-planned actions to protect information, processes and services from possible threats. Threats range from act of terrorism, industrial espionage, etc., or even a simple unintentional human error by an operator.

Standards promoted by the International Organization for Standardization (2011) on IS security suggest three-stage risk analysis and management methodologies. The planning stage establishes the necessary points for starting up the project, defines objectives, and identifies participants and competencies. The analysis stage identifies the IS assets, as well as their relations (dependencies), the threats to which they are exposed and their frequency and asset degradation levels. Finally, the risk management stage determines the safeguards and strategies that reduce impact and risk.

In this paper, we focus on the second stage, analysis. Assets are the IS or related resources, necessary for an organization’s correct operation and for achieving the goals set by its manager. Assets can be data, applications, software, facilities, hardware, services...

The asset dependencies are usually represented in terms of percentages, signaling how likely the failure of an asset is to affect another. Often only a few elements (terminal assets), usually data or services, account for the total value of an organization’s assets. The value of these assets is transferred to other assets through the established dependency relations. Thus, non-terminal assets have no intrinsic values; they accumulate their value from terminal assets.

However, the methodologies based on international standards, such as (López-Crespo et al, 2006),
MEHARI (2010), CRAMM (2003), OCTAVE (Alberts and Dorofee, 2002) and OCTAVES (Alberts and Dorofee, 2005) or NIST 800-30 (Stoneburner and Gougen, 2002), obviate the difficulty of correctly assigning asset dependencies, as well as terminal asset values or the impact on the entire system caused by the materialization of a threat to an asset. Moreover, these methodologies do not consider uncertainty concerning these assessments.

In this paper we propose a fuzzy risk analysis in IS as a solution to these deficiencies. We use the arithmetic proposed by (Xu et al, 2010), extending methodologies that valuate the asset dependencies proposed by international standards to a fuzzy framework adding fuzzy linguistic terms to valuate the different elements (terminal asset values, asset dependencies...) in risk analysis. Section 2 reviews some operations on trapezoidal fuzzy numbers and introduces a fuzzy evaluation of asset dependencies. Section 3 provides a fuzzy valuation of assets on the basis of five components is provided. Threats and asset risk impact indicators are described in Section 4. In Section 5, we introduce the similarity function used to associate a linguistic term from a set with a trapezoidal fuzzy numbers. Finally, some conclusions and future research are discussed in Section 6.

2. FUZZY VALUATION OF DEPENDENCES

Let us consider the set of trapezoidal fuzzy numbers with support in [0,1], $TF[0,1]$, i.e. $\mathcal{A} = (a, b, c, d; w_{\mathcal{A}})$, with $0 \leq a \leq b \leq c \leq d \leq 1$; $0 \leq w_{\mathcal{A}} \leq 1$. We use the following arithmetic proposed in (Xu et al, 2010) in $TF[0,1]$: If $\mathcal{A} = (a_1, b_1, c_1, d_1; w_{\mathcal{A}})$ and $\mathcal{A}_2 = (a_2, b_2, c_2, d_2; w_{\mathcal{A}_2})$, then

$$\mathcal{A} \oplus \mathcal{A}_2 = (a_1 + a_2 - a_1, b_1 + b_2 - b_1, c_1 + c_2 - c_1, d_1 + d_2 - d_1; \min\{w_{\mathcal{A}}, w_{\mathcal{A}_2}\})$$

$$\mathcal{A} \otimes \mathcal{A}_2 = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2, d_1 \times d_2; \min\{w_{\mathcal{A}}, w_{\mathcal{A}_2}\})$$

Let us demonstrate that both operations ($\oplus$ and $\otimes$) are well defined. Operations $\oplus$ and $\otimes$ are two internal composition laws in $TF[0,1]$ that verify the following properties: both are commutative, have a neutral element and are associative.

Note that the set $TF[0,1;1] = \{(a, b, c, d; 1) \in TF[0,1]\}$ is a subset of $TF[0,1]$ closed to operations $\oplus$ and $\otimes$. This means that confined to $TF[0,1;1]$ such operations remain internal composition laws. From now on, we will consider the framework defined by $TF[0,1;1]$ and, for convenience, use $(a, b, c, d; 1)$ notation.

As mentioned above, the assets in IS are connected by dependency relationships, and a failure of one asset may affect other assets. The structure resulting from these dependency relationships is as shown in Fig. 1, where terminal assets (data and products or services) account for total system assets.

![Figure 1. Asset dependencies graph.](image)

Asset $A_i$ depends on the asset $A_i$, (or $A_i$ influences $A_i$), denoted by $(A_i, A_i)$ (graphically $A_i \rightarrow A_i$), if a failure in asset $A_i$ causes a failure in the asset $A_i$ with any given probability. This probability is usually referred to as the degree of dependency of $A_i$ with respect to $A_i$, or the influence of $A_i$ over $A_i$, denoted by $d_{ij}(A_i, A_i)$.

Proposed IS risk analysis methodologies (MAGERIT, MEHARI, OCTAVE...) assign just a percentage to indicate the degree of dependency between two assets, and sometimes even propose the use of a Boolean value indicating whether or not this dependency exists regardless of the degree of dependency. We propose...
the use of trapezoidal fuzzy numbers to represent these dependencies. Consequently, \( \tilde{d}_s(A_i, A_j) \in TF[0, 1] \) and the experts can build a linguistic term set to intuitively define the dependency between two assets under uncertainty.

The dependency between assets in the dependency structure need not be direct but can be transitive. Namely, if \((A_i, A_j)\) and \((A_j, A_k)\), then \((A_i, A_k)\). Our aim then is to compute the indirect asset dependencies since assets values are accumulated from terminal assets through these dependencies.

To avoid ambiguity (see Fig. 3), we will write \( D_o \) to refer to total dependency between two assets separated by other intermediate assets, and \( d_s \) when they are directly connected. The degree of dependency of asset \( A_i \) with respect to \( A_j \), \( \tilde{D}_o(A_i, A_j) \), is computed as follows. We denote by \( P = \{ P_1, \ldots, P_r \} \) the set of paths in the analysis of the influence of \( A_i \) over \( A_j \). Then,

**A)** If all assets (excluding \( A_i \) and \( A_j \)) in the paths in \( P \) are influenced by only one asset, then

\[
\tilde{D}_o(A_i, A_j) = \bigoplus_{j=1}^{r} \tilde{D}_o(A_i, P_j) \tag{1}
\]

where \( \tilde{D}_o(A_i, P_j) = \tilde{d}_o(A_i, A_{j_1}) \otimes \tilde{d}_o(A_{j_1}, A_{j_2}) \otimes \cdots \otimes \tilde{d}_o(A_{j_n}, A_j) \) and \( P_j : (A_i \rightarrow A_{j_1} \rightarrow \ldots \rightarrow A_{j_n} \rightarrow A_j) \).

**B)** Otherwise, we assume that the first \( r \) paths in \( P \) are formed by assets (excluding \( A_i \) and \( A_j \)) influenced by only one asset, and the remaining \( s-r \) paths include at least one asset influenced by two or more assets. Then, for the \( r \) first paths, we proceed as in **A**, and we denote by \( S \) the set including the \( s-r \) remaining paths. We proceed with \( S \) as follows:

i. Compute the set of non-terminal assets in \( S \) influenced by two or more assets, denoted by \( I \), and the subset of \( I \) including assets uninfluenced by any other asset in \( I \), denoted by \( NI \).

ii. We consider an asset \( A_k \) in \( NI \). Then, we simplify the paths in \( S \) that include asset \( A_k \), making \( A_i \rightarrow A_k \rightarrow \ldots \rightarrow A_j \), with \( \tilde{d}_o(A_i, A_j) = \tilde{D}_o(A_i, A_j) \) (computed as in **A**).

iii. Remove repeated paths from \( S \) and keep only one instance

iv. Build \( I \) and \( NI \) again from \( S \).

v. If \( NI \) is not empty, and go to ii). Otherwise, the algorithm finishes.

Let us denote the resulting set of paths by \( S = \{ P_3, \ldots, P_m \} \), with \( m \leq s-r \). Then, the degree of dependency of \( A_i \) regarding \( A_j \) is

\[
\tilde{D}_o(A_i, A_j) = \bigoplus_{j=3}^{m} \tilde{D}_o(A_i, P_j) \otimes \tilde{d}_o(A_i, P_j) \tag{2}
\]

Fig. 2 shows an example of dependency structure in IS. The degree of dependence of \( A_6 \) with respect to \( A_1 \) is computed as follows. First, \( P = \{ P_1 : (A_1 \rightarrow A_2 \rightarrow A_3 \rightarrow A_4), P_2 : (A_1 \rightarrow A_2 \rightarrow A_3 \rightarrow A_4), P_3 : (A_1 \rightarrow A_2 \rightarrow A_3 \rightarrow A_4) \} \).

Asset \( A_4 \) is influenced by \( A_1 \) and \( A_3 \), and \( A_2 \) is influenced by \( A_1 \) and \( A_3 \). Therefore, we apply **B** with \( r = 2 \) and \( S = \{ P_3, 3_P_4, P_5, P_6 \} \) and proceed as follows:

i. \( I = \{ A_1, A_3 \} \) and \( NI = \{ A_4 \} \).

ii. We select \( A_4 \), then we simplify the paths \( P_2, P_4, P_5, P_3 \) to \( P_5 : (A_1 \rightarrow A_3 \rightarrow A_4), P_3 : (A_1 \rightarrow A_3 \rightarrow A_4 \rightarrow A_5) \), \( P_5 : (A_1 \rightarrow A_3 \rightarrow A_4 \rightarrow A_5), \) and \( P_5 : (A_1 \rightarrow A_4 \rightarrow A_5) \), respectively, with

\[
\tilde{d}_o(A_i, A_j) = \tilde{D}_o(A_i, A_j) = (\tilde{d}_o(A_i, A_j) \otimes \tilde{d}_o(A_j, A_k)) \otimes \tilde{d}_o(A_k, A_l) \tag{3}
\]

iii. \( S = \{ P_2, P_5 \} \), since \( P_5 = P_4 \) and \( P_4 = P_3 \).

iv. \( I = \{ A_4 \} \) and \( NI = \{ A_1 \} \).

v. Go to (ii).

ii. We select \( A_4 \), then we simplify the paths \( P_3, P_6 \) to \( P_3 : (A_1 \rightarrow A_4 \rightarrow A_6) \) and \( P_6 : (A_1 \rightarrow A_4 \rightarrow A_6) \), respectively, with

\[
\tilde{d}_o(A_i, A_j) = \tilde{D}_o(A_i, A_j) = (\tilde{d}_o(A_i, A_j) \otimes \tilde{d}_o(A_j, A_k)) \otimes \tilde{d}_o(A_k, A_l) \tag{4}
\]

iii. \( S = \{ P_3, P_6 \} \), since \( P_6 = P_3 \).

iv. \( I = \emptyset \) and \( NI = \emptyset \).

v. The algorithm finishes since \( NI = \emptyset \).

Finally, \( S = \{ P_3, P_6 \} \) and the degree of dependence of \( A_6 \) with respect to \( A_1 \) is
\[
\hat{D}_d(A_1 | A_1) = \hat{D}_d(A_1, A_1 | P_1) \oplus \hat{D}_d(A_1, A_1 | P_2) \oplus \hat{D}_d(A_1, A_1 | P_3) \oplus \hat{D}_d(A_1, A_1 | P_4)
\]
\[
= (\hat{d}_d(A_1, A_1) \ominus \hat{d}_d(A_2, A_1)) + (\hat{d}_d(A_1, A_1) \ominus \hat{d}_d(A_3, A_1)) +
(\hat{d}_d(A_1, A_1) \ominus \hat{d}_d(A_4, A_1)) + (\hat{d}_d(A_1, A_1) \ominus \hat{d}_d(A_5, A_1))
\]

Figure 2. Asset dependencies structure in ISs.

Note that transactions between trapezoidal fuzzy numbers representing linguistic terms from a set in \([0,1]\) will remain in \(TF[0,1;1]\), and the results of these operations can be translated into one of the linguistic terms of the set by means of a similarity function. Furthermore, the operation \(\oplus\) is consistent with the methodologies established for risk analysis and management in IS, allowing performances in probabilistic terms.

Let us consider these issues in more detail. The MAGERIT (López-Crespo et al, 2006) methodology uses real numbers to determine both the dependency and the asset values, as mentioned before, and proposes the operation \(a \oplus b = a + b - ab\).

Operation \(\ominus\) is a special case of the operation proposed in (Xu et al, 2010) and used in this paper. \(\ominus\), since a real number \(a \in [0,1]\) can be written as the trapezoidal fuzzy number \(\tilde{a} = (a, a, a, a)\), and therefore \(\tilde{a} \ominus \tilde{b} = (a, a, a) \ominus (b, b, b, b) = (a + b - ab, a + b - ab, a + b - ab, a + b - ab) = a \ominus b = a \ominus b\).

On the other hand, operation \(\ominus\) extends naturally to the product of real numbers. Therefore, by defining operations \(\oplus\) and \(\ominus\), we have successfully extended the basic operations using IS risk analysis and management methodologies to the context of fuzzy numbers.

Probability theory is the source of the second reason for using the operation \(\oplus\). To illustrate this point, we shall use the examples in Fig. 3. In the first example, a failure in asset \(A_1\) has the given probabilities of causing a failure in asset \(A_2\) by means of \(A_3\) or \(A_4\). As both paths are not necessarily mutually exclusive, the computation of probabilities is \(P = p_1p_3 + p_2p_4 - p_1p_3p_4 = p_1 \ominus p_3 \ominus p_4 \approx [p_1 \ominus p_3] \ominus [p_4 \ominus p_4],\) where \(\tilde{a} = (a, a, a, a) \approx a\) is the fuzzy representation of the real number \(a\).

Figure 3. Asset dependencies structure with two and three paths.

Suppose that we have three instead of two alternative paths, see the second example in Fig. 3, and we assume that the total probabilities for these paths are \(p_1, p_2\) and \(p_3\) (for convenience, we disregard the intermediate assets). Thus, according to probability theory, \(P = p_1 + p_2 + p_3 - p_1p_2 - p_1p_3 - p_2p_3 = p_1 \ominus p_2 \ominus p_3\), and, by induction on the number of paths between \(A_1\) and \(A_2\), we can infer that for a set of real numbers \(\tilde{a} = (a, a, a, a)$$
This expression can obviously be extended to fuzzy numbers in $TF[0,1;1]$, componentwise, with the sum and product operations ($\oplus$ and $\otimes$). Given these operations, the methodology for deriving the dependency from each terminal asset is: First, we establish a set of fuzzy linguistic terms. Then, the experts identify the degree of dependency for each pair of consecutive assets in the general dependency structure using linguistic terms in the above set. Finally, the degree of dependency on assets with respect to terminal assets is computed using Eqs. (1) or (2).

As an example, let us consider the dependency structure in Fig. 4, including the degree of dependency for each pair of assets on the basis of the linguistic term shown in Table 1. Table 2 shows the degree of dependency of nonterminal assets with respect to $A_6$.

### Table 1. Linguistic term set

<table>
<thead>
<tr>
<th>Term</th>
<th>Fuzzy Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low (VL)</td>
<td>(0, 0, 0, 0.05)</td>
</tr>
<tr>
<td>Low (L)</td>
<td>(0, 0.075, 0.125, 0.275)</td>
</tr>
<tr>
<td>Medium-Low (M-L)</td>
<td>(0.125, 0.275, 0.325, 0.475)</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>(0.325, 0.475, 0.525, 0.675)</td>
</tr>
<tr>
<td>Medium-High (M-H)</td>
<td>(0.525, 0.675, 0.725, 0.875)</td>
</tr>
<tr>
<td>High (H)</td>
<td>(0.725, 0.875, 0.925, 1)</td>
</tr>
<tr>
<td>Very High (VH)</td>
<td>(0.925, 1, 1, 1)</td>
</tr>
</tbody>
</table>

### Figure 4. Asset dependencies.

### Table 2. Accumulated degree of dependency for non-terminal assets

<table>
<thead>
<tr>
<th>$A_i$</th>
<th>$\tilde{D}_i(A_i, A_6)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>(0.679, 0.891, 0.949, 1)</td>
</tr>
<tr>
<td>$A_2$</td>
<td>(0.725, 0.875, 0.925, 1)</td>
</tr>
<tr>
<td>$A_3$</td>
<td>(0, 0.107, 0.182, 0.409)</td>
</tr>
<tr>
<td>$A_4$</td>
<td>(0, 0.075, 0.125, 0.275)</td>
</tr>
<tr>
<td>$A_5$</td>
<td>(0, 0, 0, 0.05)</td>
</tr>
</tbody>
</table>

### 3. FUZZY SETS VALUATIONS

MAGERIT defines the value of an asset as the losses that would be sustained if the respective asset is no longer available. These can be losses of money, user confidence, the organizational prestige... Assets are usually evaluated taking into account the following five components (López-Crespo et al, 2006):

- **Confidentiality**. How much damage would it cause if the asset is disclosed to someone it should not be?
- **Integrity**. How much damage would it cause if the asset is damaged or corrupt? Data can be manipulated, be wholly or partially false, or even missing.
- **Authenticity**. How much damage would it cause if we do not exactly know who has done what? This is a typical services (user authentication) and data (authenticity of the person accessing data inspection).
• **Traceability.** How much damage would it cause if it is not known for whom the service is being provided?, i.e. who does what and when? How much damage would it cause if it is not known who accessed what data and what they did with them?

• **Availability.** How much damage would it cause if the asset is not available or cannot be used?

Confidentiality, integrity, and availability are typical data inspections. Only the terminal assets have an associated value for the above components. The other assets accumulate value from terminal assets on the basis of dependency relationships. We again use the set of linguistic terms that represent trapezoidal fuzzy numbers to represent uncertainty when valuating the terminal assets.

Let us denote assets by \( A_j \) for the \( j \)-th asset, where \( j = 1, 2, 3, \ldots, n \), and terminal asset set, then the value of asset \( A_j \) with respect to terminal assets is given by

\[
\text{Value of asset } A_j = \mathcal{V} (A_j) = \bigotimes_{A_k \in T A S} (\mathcal{D}(A_j, A_k)) \mathcal{V}_k,
\]

where the expression is for the \( k \)-th value component in asset \( A_j \). If we denote by \( T A S \) the terminal asset set, then the value of asset \( A_j \) with respect to terminal assets is

\[
\mathcal{V} (A_j) = \bigotimes_{A_k \in T A S} (\mathcal{D}(A_j, A_k)) \mathcal{V}_k.
\]

If the values provided by expert for the five components in the terminal asset \( A_k \) are confidentiality (H), integrity (I), authenticity (M), traceability (L) and availability (H), then the accumulated values for the non-terminal asset \( A_j \) are shown in Table 3.

<table>
<thead>
<tr>
<th>Component</th>
<th>( \mathcal{V}_k )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidentiality</td>
<td>(0.492, 0.779, 0.877, 1)</td>
</tr>
<tr>
<td>Integrity</td>
<td>(0.492, 0.779, 0.877, 1)</td>
</tr>
<tr>
<td>Authenticity</td>
<td>(0.220, 0.423, 0.498, 0.675)</td>
</tr>
<tr>
<td>Traceability</td>
<td>(0, 0.066, 0.118, 0.275)</td>
</tr>
<tr>
<td>Availability</td>
<td>(0.492, 0.779, 0.877, 1)</td>
</tr>
</tbody>
</table>

### 4. Threats

Next, we assess threats and estimate indicators of the impact on and risk to assets. A **threat** is an event that can trigger an incident in our organization, causing damage or intangible material loss to the assets, and an **attack** is any deliberate action aimed at violating the IS security mechanisms. MAGERIT suggests two threat assessment measures: degradation, the damage that the threat can cause to the asset, and frequency, how often the threat materializes.

We will again use fuzzy linguistic terms rather than percentages and probabilities to represent degradation and frequency. A threat is a vector \( \tilde{d} = (\tilde{D}, \tilde{f}) \) whose components are degradation and frequency. Note that the degradation has to be established for each the five asset components described in the previous section, where \( \tilde{D} = (\tilde{d}_1, \tilde{d}_2, \tilde{d}_3, \tilde{d}_4, \tilde{d}_5) \) i.e., the threat causes a degradation \( \tilde{d}_i \) in the \( i \)-th component of the asset.

Let us consider a threat on the asset \( A_j \). When the threat is realized, each component is affected by the expression \( \tilde{I} = \tilde{d} \mathcal{V} \), where \( \tilde{I} \) is the impact on the \( i \)-th component of the attacked asset \( A_j \).

We compute the **risk** to the attacked asset by the expression \( \tilde{R} = \tilde{I} \mathcal{V} \). After computing the impact caused by a materialized threat on an asset, we can compute the impact transmitted from the attacked asset to its dependent assets. If \( A_i \) is the asset on which the threat has materialized and the degree of dependency of \( A_i \) with respect to \( A_k \) is \( \mathcal{D}(A_i, A_k) \), then the attack on asset \( A_j \) has an impact on \( A_k \) of \( \tilde{I} = \mathcal{D}(A_i, A_k) \mathcal{V} \). Thus, the risk to asset \( A_k \) is \( \tilde{R} = \tilde{I} \mathcal{V} = \mathcal{D}(A_i, A_k) \mathcal{V} \mathcal{V} \). We consider a threat on asset \( A_j \), see Fig. 4, with a degradation \( \mathcal{D} = (H, L, M, VL, M) \) and frequency M, respectively. Then, the impact on and the risk to资产 \( A_i \) are shown in Table 4.

The impacts on and risk to the assets depending on \( A_i \), i.e. \( A_j \) and \( A_k \), are now computed, see Table 4. Note that the low impacts on and risks to \( A_j \) are due to the dependency between \( A_2 \) and \( A_4 \) is very low (VL), see Fig. 4, with an associated trapezoidal fuzzy number (0, 0, 0, 0.05).
Table 4. Impact and risk to $A_3$

<table>
<thead>
<tr>
<th>Component</th>
<th>Impact on $A_1$</th>
<th>Risk to $A_1$</th>
<th>Risk to $A_2$</th>
<th>Risk to $A_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidentiality</td>
<td>$(0, 0.081, 0.155, 0.409)$</td>
<td>$(0.037, 0.143, 0.223, 0.466)$</td>
<td>$(0, 0, 0.033)$</td>
<td>$(0, 0.038, 0.081, 0.276)$</td>
</tr>
<tr>
<td>Integrity</td>
<td>$(0, 0.007, 0.021, 0.112)$</td>
<td>$(0, 0.013, 0.03, 0.128)$</td>
<td>$(0, 0, 0.009)$</td>
<td>$(0, 0.003, 0.011, 0.075)$</td>
</tr>
<tr>
<td>Authenticity</td>
<td>$(0, 0.024, 0.050, 0.186)$</td>
<td>$(0.007, 0.045, 0.072, 0.212)$</td>
<td>$(0, 0, 0.015)$</td>
<td>$(0, 0.011, 0.026, 0.125)$</td>
</tr>
<tr>
<td>Traceability</td>
<td>$(0, 0, 0, 0.005)$</td>
<td>$(0, 0, 0, 0.006)$</td>
<td>$(0, 0, 0, 0.0004)$</td>
<td>$(0, 0, 0, 0.038)$</td>
</tr>
<tr>
<td>Availability</td>
<td>$(0, 0.044, 0.088, 0.27)$</td>
<td>$(0, 0.013, 0.03, 0.128)$</td>
<td>$(0, 0, 0.002)$</td>
<td>$(0, 0.021, 0.046, 0.186)$</td>
</tr>
</tbody>
</table>

5. SIMILARITY FUNCTION

A similarity function is required to associate the resulting trapezoidal fuzzy number with an element in the linguistic term set. This function can also be used at any step of the methodology to derive the linguistic terms associated with the respective trapezoidal fuzzy numbers output to represent dependencies, accumulated values...

Several authors have proposed different similarity functions, which are based on the centroid of a fuzzy number and the distance between the components of the fuzzy numbers in $TF[0,1]$, see (Hsieh and Chen, 1999; Chen and Chen 2003, 2007). A more recent similarity function was proposed in (Xu et al, 2010) and compared with the proposal reported in (Chen and Chen, 2007).

However, the above similarity functions are unsuitable for use in $TF[0,1;1]$. We use the function proposed in (Vicente et al, 2012), which considers another parameter consisting of the ratio between the common area and the joint area under the membership functions of trapezoidal fuzzy numbers. Moreover, we use the distance $l_\infty$ between centroids since the use of distances with nonrectangular spheres is inconsistent with the intuitive perception of similarity in $TF[0,1;1]$. Given $\tilde{A}$ and $\tilde{B} \in TF[0,1;1]$, the similarity function can be defined as

$$S(\tilde{A}, \tilde{B}) = 1 - w_1 \left( 1 - \frac{\int_0^1 \mu_{\tilde{A} \cap \tilde{B}}(x)dx}{\int_0^1 \mu_{\tilde{A}}(x)dx} \right) - w_2 \frac{\sum |a_i - b_i|}{4} - w_3 \int_{\chi} \left[ (X_{\tilde{A}}^1, Y_{\tilde{A}}^1)(X_{\tilde{B}}^1, Y_{\tilde{B}}^1) \right],$$

where $w_1 + w_2 + w_3 = 1$, $(X_{\tilde{A}}^1, Y_{\tilde{A}}^1)$ and $(X_{\tilde{B}}^1, Y_{\tilde{B}}^1)$ are the centroids of $\tilde{A}$ and $\tilde{B}$, respectively, i.e.

$$X_{\tilde{A}} = Y_{\tilde{A}}^1 (a_1 + a_2) + (1 - Y_{\tilde{A}}^1)(a_3 + a_4) \quad \text{and} \quad Y_{\tilde{A}} = \begin{cases} \frac{a_1 - a_2}{a_2 - a_1} + 2, & \text{if } a_1 - a_2 \neq 0, \\ 1/2, & \text{if } a_1 - a_2 = 0 \end{cases},$$

$$\mu_{\tilde{A} \cap \tilde{B}} = \min_{x \in \chi} \{ \mu_{\tilde{A}}(x), \mu_{\tilde{B}}(x) \}, \quad \mu_{\tilde{A}} = \max_{x \in \chi} \{ \mu_{\tilde{A}}(x), \mu_{\tilde{B}}(x) \},$$

with $\mu_{\tilde{A}}$ the membership function of $\tilde{A}$, and $l_\infty((x_1, y_1), (x_2, y_2)) = \max \{|x_1 - x_2|, |y_1 - y_2|\}$.

5. SIMILARITY FUNCTION

5. SIMILARITY FUNCTION

Note that $w_1$, $w_2$, and $w_3$ represent the relative importance of the three elements considered in the similarity function. Analysts will assign the values that best fit their own model.

Looking at the same example than in previous sections, applying the similarity function with equal weights for all three components, then the corresponding linguistic terms for the risk to assets $A_1$, $A_2$, and $A_3$ are shown in Table 6. Fig. 5 shows the risk components to $A_1$.

6. CONCLUSIONS

We have developed a fuzzy risk analysis model for information systems that conforms to international standards, particularly the MAGERIT methodology. The model is an improvement on this and other existing methodologies since it includes uncertainty about the assessments by means of linguistic terms, which have associated trapezoidal fuzzy numbers. The proposed methodology makes computations on the basis of trapezoidal fuzzy numbers to accumulate dependencies between assets and asset valuations and to determine impacts and risk from the threat degradation and frequency, respectively. Moreover, similarity functions can be used at any step in the methodology to derive a linguistic term for the trapezoidal fuzzy number output.
ACKNOWLEDGEMENT

The paper was supported by Madrid Regional Government project S-2009/ESP-1685 and the Spanish Ministry of Science and Innovation project MTM2011-28983-C03-03.

REFERENCES

VISUALIZATION OF GEO-REFERENCED ENTITY: AN ASPECT-ORIENTED PATTERN

Armanda Rodrigues, Sara Silva and João Araújo
CITI/FCT, Universidade Nova de Lisboa - Quinta da Torre, 2829-516 CAPARICA, PORTUGAL

ABSTRACT
Web Geographic Information Systems (GIS) are systems composed by software, hardware, spatial data and computing operations, which aim to collect, model, store, share, retrieve, manipulate and display geographically referenced data. The development of online geospatial applications is currently on the rise, but this type of application often involves dealing with concerns (i.e., properties) which are inherently volatile, implying a considerable effort for system evolution. Nevertheless, geospatial concerns (e.g., geographically locating dispersed staff needed for a meeting), although changeable, are reusable. However, lack of modularization in software artifacts (including system’s models) can compromise reusability. In this context, the use of requirements analysis patterns, enriched with aspect-oriented modeling techniques, can support reusability and improve modularity. In this paper, we introduce a requirements analysis pattern for visualizing geo-referenced entities. This pattern is obtained from the domain analysis of Web GIS applications and described using a template which is supported by a comprehensive tool, presented in this paper.

KEYWORDS
Web GIS; Analysis Patterns; Spatial Concerns; Aspect-Oriented Modeling.

1. INTRODUCTION
According to Dragicevic (2004), a Geographic Information System (GIS) is a computer system that supports the use and handling of geo-referenced data. Web GIS involves the online availability of Geospatial data, with the associated tools. The development and availability of online geospatial applications is currently on the rise. This type of application often involves the temporary availability of spatial concerns (i.e., properties), inherently volatile, although recurring and, therefore, reusable (e.g., temporarily blocked streets). This implies a considerable need for maintenance, not only of the respective information structures, but also of its dynamic behavior. Also, the lack of modularization can compromise flexibility and lead to reuse problems. Moreover, maintenance must be undertaken with full knowledge of the application domain and using proper technical maintenance support techniques.

Based on knowledge of the application domain, resulting from preliminary domain analysis, the identification of reusable (in our case, spatial) concerns (e.g., map adjustment according to temporal conditions, geographic interfaces) will facilitate Web GIS development. To help with this task at early stages of software development, requirements analysis patterns may be applied to spatial concerns. Analysis patterns (Fowler, 1997) are reusable specifications, used at early stages of the development process. The reuse of patterns and their instantiation in a particular Web GIS application analysis models will speed the development process.

We propose an approach to improve modularization when modeling Web GIS during the requirements specification. The aim of this work is thus to promote requirements modularity and reusability and hence the evolution of Web GIS applications. Nevertheless, the reuse of spatial concerns depends on the availability of appropriate modularization and composition mechanisms. It is important to identify, not only spatial concerns, but also other concerns which are related to these. Moreover, the transverse quality of these concerns must be taken into account, as relevant spatial concerns crosscut various parts of an application.

Aspect-Oriented Software Development (AOSD) is characterized by allowing the identification, modularization and composition of crosscutting properties (or concerns) (Filman et al., 2005). One property is said to be crosscutting if it is tangled with another property in a single module or if it is scattered in several
system modules. Aspect-orientation is a software reuse paradigm and perfectly suits the specification of patterns’ models, as it provides efficient mechanisms to reuse and compose pattern’s models to a specific application. In this work we adopt the MATA (Modeling Aspects Using a Transformation Approach) (Whittle et al., 2009), a technique for modeling and composition of patterns based on graph transformations.

In summary, the aim of this work is to use an aspect-oriented requirements analysis approach to model volatile but reusable concerns in Web GIS, specifically geospatial properties, based on patterns. To efficiently support the development of any type of application, it is more productive to have its domain analysis available, and a catalogue of associated analysis patterns. Geospatial applications are no exception. It is also important to define these patterns using an appropriate template for geospatial applications, whose solution models are specified using aspect-oriented principles, enabling the systematic reuse of spatial properties. More specifically, in this paper, we focus on the definition of a pattern for the visualization of geo-referenced entities.

The remaining of this paper is organized as follows. Section 2 gives some background on spatial concerns and aspect-oriented modeling. Section 3 presents the proposed requirements analysis pattern template, its application to a case-study and the pattern tool. Section 4 depicts some related work. Section 5 draws some conclusions and points directions for future work.

2. BACKGROUND

2.1 Spatial Concerns

The use of GIS implies the handling of large volumes of data which are visually integrated in a spatial framework and which, at the same time, need the availability of efficient and adapted data manipulation operations. The highly dimensional operation of GIS data involves the development of complex applications, where relevant concerns may crosscut various parts of a particular application.

The availability of map APIs, enabling the development of geospatial components for existing web services (e.g., Google, Flickr, Facebook, etc.) along with the popularization of the use of Global Positioning Services (GPS), has led to the growing numbers of Location-Based Applications on the Internet and Mobile Internet. We will name this type of applications, Web GIS applications. They have taken the GIS concept, which was previously mainly used by natural sciences professionals and researchers, to the widespread theatre of the Internet and Mobile Devices, providing location-based adaptations of existing popular services. This means that searching for a favorite type of restaurant can now be made around the area where a smart phone is located. Also, you can quickly discover the nearest cinema presenting the film that you want to watch tonight. The web context adds an additional difficulty to the development of GIS applications: requirements volatility. Not only data and availability are constantly changing but requirements evolve also. These requirements are directly related to the spatial needs behind Web GIS users and they can be identified by the use of a spatial concerns catalogue, in association with the conception of an approach for modeling spatial concerns using aspects in Web GIS applications (Oliveira et al., 2010). This catalogue is currently under development and the results of the work presented in this paper will be added to it. Mainly, typical spatial concerns can be separated in five categories, described as follows:

- Spatial Business Objects: To enhance applications by adding a spatial mapping and representation to business objects (e.g., a bus service management system can be improved by providing real-time bus locations);
- Rich Spatial Data: Enriching a geographic object with additional (not geo-referenced) information (e.g. adding a video to a specific location on a map);
- Spatially-Constrained Behavior: Change or modify the behavior of an object according to its actual location (e.g. pricing and taxing processes may change with objects’ locations);
- Map adjustments: To extend or restrict the available spatial information according to the application’s constraints (e.g. certain parts of a map may be, according to temporal or permanent restrictions, unavailable or useless for specific operations).
- Geographic Interfaces: To modify (or upgrade) the user interface of geographic objects. Though this is not strictly a spatial concern, the previously described concerns may introduce changes in the application’s
user interface, specifically in the representation of geographic objects (e.g., to introduce a particular symbolization to make the user aware that a road cannot be used during a particular period of the day.

By addressing these types of (spatial) concerns we aim to identify the situations in which they may be present in web applications and to develop and approach to handle them early on in the development process, specifically during requirements specification. Spatial Business Objects and Geographic Interfaces are the categories addressed in this paper.

2.2 Aspect-Oriented Modeling

The MATA aspect-oriented modeling approach (Whittle et al., 2009) is based on UML, allowing aspects composition using, for example, class diagrams, sequence diagrams and state diagrams. Here we focus on MATA to model aspectual classes by using and adapting class diagrams. To specify aspectual classes, some stereotypes are used to define composition rules, for example, <<create>>, which states that the element will be created in the base model.

Variables in MATA are prefixed by a vertical bar “|”, meaning that “|X” will match any model element with the same type of X. After specifying both kinds of models, base and aspectual, a pattern matching is made between them. This means that the MATA tool tries to establish a connection between elements of each model, always respecting the composition rules defined in the aspectual model. The resulting composed model includes the elements of both models, according to the rules defined. MATA allows more composition combinations than other existing aspect-oriented modeling tools. Detailed use of MATA models are shown in the pattern definition.

3. PATTERN DEFINITION

The proposed template begins with the name of the pattern, followed by the description of the problem which it seeks to solve, the problem context and applicability of this pattern. The functional and non-functional requirements of this pattern are also listed. Then, the pattern’s models are provided: a feature model (Kang et al., 1990) (to represent variability), a class diagram (for the domain classes) and a sequence diagram (to specify behavior). This template includes the specification of non-functional requirements and feature models – these are not explicitly considered in other templates, but from our perspective they are essential to be used in web applications in general. The consequences of pattern’s application and the list of possible events where the pattern can be applied are also defined. The template used here to define the Show a Geo-referenced Entity Pattern is based on the one proposed in Silva et al. (2012). Finally, in section 3.1, and example is applied to the pattern.

Name: Show a Geo-referenced Entity

Problem: For users to benefit from a Geo-referenced Web application, geo-referenced entities must contemplate a visual representation. This means some cartographic representation of the application’s data set must exist, and each geo-referenced object must has a visual representation with possibly spatial behavior associated with it. Therefore, a change associated with the object’s data may involve a change in the visual representation of the object.

Context: This can be applied to the handling of geospatial objects with, initially, no visual representation but may also apply to objects which have experienced changes in their state, thus being subjected to change in their visual representation also. For example, a street that is closed for works, may be drawn differently from other open streets. This change maybe volatile, time constrained. Volatility may also be associated with the object’s location in itself. The assumptions taken are that the applications’ entities are either static (do not move in space, e.g.: a garage) or mobile (may move during the execution of the application, e.g.: a bus or a person). A static entity is associated with a location, while a mobile entity may be associated with several locations, during the execution of the application. It is also assumed that a mobile entity holds a main location (which can be home, an office, a garage) but, as it moves, it may become associated with a secondary location. This secondary location may be obtained from the analysis of the entity’s schedule and requested from static entities, referenced in the schedule. This means that a bus may be located at a bus stop, which is a static location, or on route to the next stop and, at this time, its location is the street it is traversing,
which is also a static location. As the location of the object changes, its state may also change and this may involve a change in the way the object is presented to the user, in the map.

**Requirements:**

**Functional**

1. Get geo-referenced entity;
2. Check if the entity is static or mobile:
   2.1. If static, obtain the geographic reference data;
   2.2. If mobile, obtain system time and entity’s schedule:
   2.2.1. Obtain the details of the entity’s location;
3. Get the graphical representation of the entity (may be an XML representation);
4. Check if there are any restrictions / information to add to the entity
4.1. If there are, add the restrictions / information relating to the representation of the entity;
5. Get map;
6. Overlap the graphical representation of the entity to the map;

**Non-Functional**

1. Correctness:
   1.1. In obtaining the entity, the geographic reference of the static entity, the system time, the schedule associated with the entity, the main location, the secondary location and the graphical representation of the entity;
   1.2. At checking whether the entity is static or mobile and if the entity is in a secondary location;
   1.3. In verifying and obtaining restrictions;
   1.4. In overlaying geo-referenced objects on the map;
2. Response Time:
   2.1. when checking whether the entity is static or mobile;
   2.2. when obtaining the geographic reference of the static entity, the system time, the schedule associated with the entity, the main location, the secondary location, the restrictions and the map;
   2.3. when overlaying the object on the map.
3. Precision:
   3.1. when obtaining the geographic reference of the static entity, the system time, the schedule associated with the entity, the main location, the secondary location, the object’s graphical representation and restrictions;
   3.2. when overlaying the object on the map.

**Actors**: User; Entities; System/Application;

**Modeling**: Structural

Feature Model:

Fig. 1 illustrates a feature model to *Show a Geo-referenced Entity*.

![Feature Model for Show Geo-referenced Entity](image)

Figure 1. Feature Model for *Show Geo-referenced Entity*

This model shows the variable and mandatory features associated to the pattern. There must be a Geo-referenced Entity which can be a Static Entity or Mobile Entity and cannot be both at the same time. Location is also compulsory, and this has a Longitude and Latitude and may or may not have an Altitude. Optionally, we can still have a Schedule. When we have a Mobile Entity, it must be associated with, at least, one Static
Entity and a Schedule. Optionally, we can have Restriction or Information. A map and the entity’s graphical representation are also compulsory. Besides specifying the variability of the pattern, this model can be used to help defining the class diagram as some features can be mapped to domain classes.

Class Diagram:

![Class Diagram](image)

In the diagram in Fig. 2 we have seven classes: Interface, Control, Locatable Entity, Schedule, Main Location, Secondary Location and Map. The class Interface is the intermediary between the user and Control, and the latter (the Control class) is responsible for checking and request the necessary data. The Control class communicates with the Locatable Entity and Map classes. The Locatable Entity has a single Schedule, one Main Location and can have several Secondary Location and may be in several Maps. One Schedule only belongs to one Locatable Entity. Main Location, as well as Secondary Location can be connected to several Locatable Entity, and a Map may have the representation of several Locatable Entity. Note that we defined those classes as variables (except Schedule and Map).

Consequences: The application of this pattern will enable the spatial location of an application’s entity to be presented visually, for example, in a map.

Events List: Possible events are:
1. Fire breaks out in a building and you must find all the occupants therein to ensure that everyone leaves the building;
2. A bus company needs to inform its users, in real time, of the location of a given bus, showing it visually on a map;
3. A company that provides technical services needs a system that enables the real time visualization of the spatial locations of its technicians, to best manage the work.

3.1 Applying the Pattern to a Case Study

Here we show the actual application of the pattern models described above. This pattern can be applied to static entities, i.e. entities that have always the same location and in this case, this is simply stored in a database. Moreover, the pattern can also be applied to mobile entities, i.e. entities that change location according to certain characteristics, such as an individual or a vehicle. As an example, let us consider the application of this pattern to the CLIP\(^1\) system, a real university information system, which provides course and schedule information of all students, teachers and other employees at Universidade Nova de Lisboa. In this system, individuals and classes are considered mobile entities, while rooms and offices are static. Let us look at a locating mobile entity example: an emergency happens and we need to convene a faculty staff meeting. Faculty members’ locations must be resolved, and the Lecturer entity must be visually represented—that is the application of the pattern.

Feature Diagram: Fig. 3 has the necessary characteristics to show a lecturer – Show Lecturer Entity. As you can see, you need an object of class Map, Lecturer, its Graphical Representation, its Schedule and its Location, and the latter must be composed of a Latitude and Longitude, and may also include an Altitude. The Lecturer may also have an Office and/or a Room.

\(^1\) http://clip.unl.pt
Class Diagram

Fig. 4 illustrates the class diagram containing only the classes related to the objects that appear in the base scenario; this scenario corresponds to the representation in a map of lecturers called for a meeting. Thus, it will need CLIP Interface, CLIP Control, Lecturer and Meeting classes. Fig. 5 shows the class diagram for the base scenario composed with the aspect. So we have the aspect’s classes instantiated with the base classes and composed with them. We thus instantiated aspect classes |Interface with CLIP Interface, |Control with CLIP Control, |Locatable Entity with Lecturer, |Main Location with Office and |Secondary Location with Class Room. The classes Schedule and Map do not need to be instantiated and the Meeting class was added to the base model.

3.2 Pattern Tool

The Pattern Tool was created to support this template, allowing the creation of patterns using the Eclipse environment. The generic view of the tool can be seen in Fig.6. The pallet of the tool is presented on the left hand side, where all the fields needed to create a pattern can be added. The fields are placed on the pallet in the order wherein they must be placed in the template. The colors help to understand when a field should be placed within another. The Pattern Template field should be the first one to be clicked, as it starts the creation of a new pattern. The hierarchy of the fields of the template is represented by a color scheme. For example, the fields to be filled within this Pattern Template are icons with dark green color, such as the Pattern’s Name field, Pattern's Requirements Analysis, among others. When a field is placed within a field with a Dark Green icon, its icon is Light Green, and finally, when a field must be placed inside a field with a Light Green icon, its icon color will be an even lighter green, as is the case of the Features Diagram icon.
To edit the feature, class and sequence diagrams, after inserting its compartment in the template, an additional editor can be opened, which can be used to build the diagram. The diagram’s editing pallet is organized like the template's pallet.

For the evaluation of the Pattern Tool we selected 15 subjects, all from the MSc on Informatics Engineering of our Faculty. Only 2 had already finished the course and were working in industry. All of them had courses on analysis models. About 85% had a course on GIS. The tool evaluation consisted of a set of questions about language expressivity and syntax, tool usability and the satisfaction level of the users.

The evaluation results were positive: the users considered the tool very useful and intuitive, easy to use and understand. The results of the tool evaluation are discussed below.

1. **How easily were the concepts identified in the tool?** The aim was to assess the quality of the concepts representation. Concerning the representation, 10 out of 15 users thought it was "very easy" to identify the concepts, while the remaining 5 considered it "easy".

2. **What is your overall impression of the tool?** The aim was to evaluate whether users liked to use the tool. In general, results were positive as 12 out of 15 users thought the tool was "good", two rated it "very good" and one of them considered it "average".

3. **Do you consider that it was easy to migrate the pattern from paper to the tool?** The aim here was to evaluate whether users felt lost while moving the pattern from paper to the Pattern Tool. The results showed that 11 out of 15 users considered the migration "easy" and 4 others considered it "very easy".

4. **Do you consider the tool useful?** The aim was to evaluate whether users felt that the tool was useful. The results were positive. They said that no other tool enabled the creation of the pattern with such detail.

Having an evaluation in the industrial/business environment would give a different perspective to the evaluation of the tool. However, the users who evaluated both the tool and the description of the pattern knew the most recent technologies, and this does not always happen in a business environment.

### 4. RELATED WORK

Oliveira *et al.* (2010) presented an aspect-oriented approach to model Web GIS applications. They developed a model to tackle low level modeling in Web GIS applications. The identification of requirements is achieved
through a thorough knowledge of the Web GIS domain, obtained by domain analysis techniques. Although this work used AOSD techniques for modeling web-GIS, it did not consider reusing patterns.

Gordillo et al. (1999) developed a technique for modeling object-oriented GIS where spatial characteristics are added to each object in a dynamic and transparent way. The work shows how reuse can be useful in this kind of applications. Also, design patterns were used as a powerful strategy for developing good design solutions to recurring problems. This work focused on design and did not use aspect techniques.

In (IJDE, 2008), a catalogue of common functionalities for defining a basic Web GIS application is proposed. However, the description of the functionalities is not as detailed as the approach presented here.

5. CONCLUSION

This work presented an approach based on aspectual analysis patterns, which was applied to enable the reuse of spatial concerns specifications in Web Geographic Information Systems, with the aim of maintaining and updating both the structural and the behavioral models of these applications, and trying to avoid flexibility and reuse problems. Web GIS applications were examined to identify some of their volatile but reusable spatial concerns, since these applications are characterized by the constant change of requirements.

Thus, an aspectual analysis pattern template was defined (and adapted from previous work) and applied to the modeling of spatial concerns patterns. One of the advantages of the template is the use of the MATA notation, an aspect-oriented modeling technique, which provides efficient mechanisms for modeling and composing static and behavioral elements of a pattern.

The spatial concern example “Show Geo-referenced Entity” was used and its analysis pattern was described. Also, a tool for patterns description was created to complement this work and applied to a real case study (the CLIP system). Some work is still under development, which includes the analysis of additional patterns, identified for other activities.

ACKNOWLEDGEMENT

The authors would like to acknowledge CTI/FCT/UNL - PEst - OE/EEI/UI0527/2011 and project Hidralerta (PTDC/AAC-AMB/120702/2010) for the financial support for this work.

REFERENCES


UNDERSTANDING OF E-COMMERCE IS THROUGH FEATURE MODELS AND THEIR METRICS

Kestutis Valincius, Vytautas Stuikys and Robertas Damasevicius
Kaunas University of Technology, Software Engineering Department, Studentu str. 50, Kaunas, Lithuania

ABSTRACT
The paper addresses the e-commerce system (interpreted here as information systems, IS) understandability problem from the maintenance and evolution perspective. We propose a methodology that includes: (1) identification of the representative systems (reference IS) through clustering based on user-oriented and temporal criteria; (2) extraction of feature models from representative systems for evaluation using similarity by absolute difference value (ADV) and complexity metrics; (3) construction of the business logic feature model, represented as metagraph, to reason about quality of systems and to understand evolution trends. The methodology is supported by experiments to evaluate the understandability problem. The basic result are: (1) feature models of the representative systems; (2) metrics to evaluate complexity and similarity and understanding the systems.

KEYWORDS
Set of e-commerce systems, reference system, feature model, understanding, similarity and complexity measures.

1. INTRODUCTION
A substantial part of software used in both large and small-to-medium enterprises are information systems for e-commerce (further IS). Such systems are seen as valuable assets for companies because they provide the underlying engines to improve processes for communication and to increase the overall market share. As it is observed by many reports (see, e.g., Lucca et al. 2006), such systems have been developed under the “pressure of short time-to-market and extremely high competition”, thus without considering a sound development methodology, their documentation is poor and, their quality is low and maintenance is difficult.

On the other hand, the user requirements to introduce new features during maintenance are constantly growing. Reasons for that are: users become more knowledgeable and are gradually better acquainted with functionality of the systems in the course of their exploitation, market pressure for new features, needs for better quality and performance in maintaining the systems. Therefore, introducing changes is a common practice. To respond to the challenges and to keep pace with arising new requirements, the systems are to be re-engineered, enhanced by new functionality. Also the improved maintenance procedures should be introduced. All these require a great deal of analysis and understanding of the IS.

The aim of the paper is to present a methodology for analysis and understanding of a set of related IS in order, first, to obtain the relevant feature models and characteristics (such similarity, functionality and complexity grow, modularization level, etc.), and then to improve the development and maintenance methodologies. The basic contribution of the paper is the identification of the reference system for a set of IS, feature-based models (including business logic metagraphs) and their characteristics that enable to improve understandability and serve for better quality in maintenance.

The IS are emerging at the rate of tsunami as it is stated in reports (Lucca et al., 2006; Patel et al., 2007, Jung, et al. 2011), where the following attributes are identified: (a) the development lacks of systematic approaches, (b) systems are kept running through a continual stream of patches; (c) systems suffer from low quality control and assurance; (d) systems have a poor structure; (e) quality of documentation is very low (if it exists at all). All these attributes are relevant to the set of IS we consider in the paper.

The increasing number of companies wants to upgrade their systems by leveraging existing IT assets (such as business rules, data), minimizing costs and reducing time. The state-of-the-practice of software maintenance and evolution employs understanding, refactoring and re-engineering techniques that focus on
code artefacts. However, recent advances have shifted the focus of evolution from the code level towards higher levels of abstraction and particularly the architectural and feature-based modelling levels (Trujillo et al., 2006; Liu et al., 2006). The ground behind this trend is that architecture and feature models capture the architectural knowledge of the IS, thus facilitate making new design decisions during evolution cycles, having full knowledge of past decisions.

There are increasingly overlapping ideas in the areas of reverse engineering (RE), program understanding, refactoring, and model-driven development, all of which deal with program structure and maintenance or related with that (Batory, 2007). More details on feature modelling can be learnt from (Apel and Ch. Kästner, 2009; Ceri et al., 2007; Karam et al., 2008). The extensive analysis on program understanding is given in (Stuijks V. and Damaševičius, 2013, 174-178 p.). RE is a well-known common approach used in many fields of software engineering, such as software understanding, maintenance and evolution (Müller et al., 2000). The aim of RE is to improve understandability, maintainability and quality. Lopez-Herrejonet et al. (2011) identify eight refactoring patterns that describe how to extract the elements of features and to effectively modularize the features for the development of variable systems. Features are treated as increments in program functionality. Modularization also improves the program structure and has impact on understandability to introducing changes and, in this way, relates to refactoring (Shonle et al., 2008; Arzoky et al. 2012) describe the extended methodology of seeding to modularise sequential source code software versions and present modularization/similarity measures (including AVD – absolute value difference). Complexity metrics for programs are described in (Lehman et. al., 1997; Damaševičius, 2009; Jung et al., 2011; Terceiro, et al., 2012) and for feature models in (Bagheri and Gasevic, 2011) from the maintainability perspective.

We summarize analysis of this part to motivate our research as follows: 1) little-by-little web-based (e-commerce) systems degrade to a legacy code comprising a class of the modern legacy code; 2) there is ever-increasing need to improve the structure of the modern legacy code.

The remaining part of the paper is organized as follows. Section 2 defines the terms and tasks. Section 3 presents the essence of the methodology. Section 4 describes evaluation of the approach and experiments. Section 5 provides conclusions.

2. BASIC TERMS AND RESEARCH TASK

2.1 Definitions of Terms

*IS for e-commerce* is the system that supports B2C activities through the Internet. *Set of IS* – a family of related systems developed using the *same open source technology* (e.g., PHP) for the e-commerce. *Reference system* is the representative system having the most essential attributes of the family, *Feature* is “an externally visible characteristic” of the system or “an increment of program functionality” (see a survey of definitions in (Apel and Kästner, 2009)). *Feature model* is the representation of a system using feature-based notation (features, relationships among types of features and variant points and constraints). *Reverse engineering* (RE) is the process of extracting higher-level representation (e.g., models, etc.) of a system from its code (Patel, et al., 2007). *Understanding of IS* – a cognition process, based on extracted artefacts (feature models) through RE, to reason about the system functionality or aiming to perform some other activities such as change and redesign. *Reconfiguring* – the process of changing either component parameters within a system (such as colour, layout, input data, etc.) without changing component functionality. *Refactoring* – reducing the number of components (or both) aiming to adapt a system to the new context of use (Batory, D., 2007).

2.2 Research Task

Given a set of systems $S = \{s_i\}, i = [1, n]$ of the same application domain (e-commerce). The systems were developed in different time slots $\Delta t$ between $[t_1, t_n]$ ($t_1 < t_i < t_n$), $\Delta t = t_{i+1} - t_i$ by different developers of the same organization, however, using the same technology. We need to identify a *reference system* among $S$ to *understand evolution* of the entire family through obtained *feature models* and their characteristics such as *similarity* between the *reference system* and other *representative systems*, changes in functionality and
complexity over time for future improvements. The set $S$ is investigated under the following characteristics: $n = 40$, $m = 7$, $t_1 = 2005$ (year), $t_7 = 2011$ (year), $\Delta t = 1$ year, $n = n_1 + n_2 + \ldots + n_m = 2+3+4+6+10+8+7$, where $n_i$ is the number of systems developed in time slot $i$. The task is formulated based on the following assumptions (hypotheses).

1. The most general understanding of a system (systems) can be gained through categorization of its constituents (subsystems, objects, characteristics, etc.) and modelling.
2. The more systems within a given set are similar, the less effort to understand the entire set is needed.
3. Understanding of a set of related systems can be gained through the evaluation of their similarity, functionality and complexity growth.

### 3. GENERAL DESCRIPTION OF THE METHODOLOGY

The methodology consists of 4 stages as a sequence of processes and models created (Figure 1).

1. Analysis and clustering of IS(s) → Defined clusters
2. UI-based reverse engineering → IS functions FMs
3. Code-based reverse engineering → IS BL FMs
4. BL FM restructuring → FM metagraph

**Legend:**
- FMs – Feature model(s)
- BL – Business logic
- IS(s) – Information system(s)
- Process
- Process outcome/model

![Figure 1. Re-engineering of e-commerce IS: a process-level view](image)

The aim of stage 1 is to reduce the search space for the identification of representative systems in order to select the reference system. The system developer analyses the systems using the available documents (e.g., initial requirements, code, users’ opinion, and experts’ comments) and performs clustering of systems as it will be explained in sub-section 3.1. The result of stage 1 is 3 representative systems (base, intermediate, and reference system) as input information for the next stages. The aim of stage 2 is to analyse the cluster of systems identified at the stage 1 and to extract from the cluster the higher-level, i.e., feature-based models that specify the system functionality. The process is based on reverse engineering. It includes mainly analysis of user interfaces though other system artefacts can be used too. As user interfaces are system dependent and, on contrary, feature-based models are system independent, we treat the latter as higher-level abstractions as compared to the first entities.

Stage 3 aims at extracting more details from the previously created model and to create the business logic feature model (BL FM) of the reference system. Stage 4 is dedicated to dealing with of the BL FM and creating a metagraph, the high-level model that provides information to understanding the set of IS from the user and designer perspectives as it will be in sub-section 3.4.

#### 3.1 Clustering of e-Commerce Systems for Similarity Identification

Aim of analysis is first to select representatives due to the large number of systems (during the time slot $[t_1, t_m]$ of about 7 years, 40 systems were developed). To identify clusters of similar systems we used two criteria: 1) time slots of duration 1 year, when a particular system was developed and 2) user profile of the system. We motivate the criteria by heuristic observations obtained from the literature and experience of the developers. We identified 7 short time slots with the indication of the number of systems developed within each time slot (see task formulation) and 4 user profile types with respect to knowledge and experience of using IT products as follows: $U_1$ – novice users having used the *same or closely related* products and business rules (BRs); $U_2$ – novice users having used *slightly different* products and BRs; $U_3$ – experienced users having used the *same or closely related* products and BRs, and $U_4$ – experienced users having used *different products* and BRs.

To simplify the clustering problem, however, we found acceptable to admit only 2 large time clusters $T_1$ and $T_2$ (each being of 3.5 years duration see Figure 2) and 2 user profiles ($U_{12}$ and $U_{34}$, meaning $U_{12} = U_1 \cup U_2$ and $U_{34} = U_3 \cup U_4$).
The aim of analysis at stage 2 and 3 is first to build models of the representative systems \( S_0, S_1 \) and \( S_k \), and then to identify the degree of the model similarity and to evaluate complexity of the models. To represent system models, we have selected feature models because they (a) describe the structure and functionality of a system at a higher-level of abstraction through entities known as features and (b) enable to simplify analysis as follows:

\[
f(S) = f^{u}(S) \cup f^{m}(S) \cup f^{p}(S),
\]

where \( f^{u}(S), f^{m}(S), f^{p}(S) \) is the user-based, the maintainer-based and the system provider-based functionality of \( S \), respectively; \( f(S) \) – the total functionality of the system from the designer’s perspective \( S \).

As it is supposed that \( f^{u}(S) \subset f^{m}(S), f^{m}(S) \subset f^{p}(S) \) meaning that user-based functionality is also taken into account in the remaining views, we are able to model representative systems considering the only its main part, that is, the user-based functionality \( f^{u}(S) \). Further, by feature models (FM) (either functional (FM) or business logic (BL FM)), we mean the models constructed to represent the \( f^{u}(S) \) view only.

Below we apply RE as a sequence of steps at stage 2 and 3 (Figure 1) to extract their feature models.

1. The base system \( S_0 \) is selected first (it represents the root of a feature model) and its UIs are navigated multiple times from the highest level interface to the lowest one. The item (UI elements) within any UI is treated as a functional feature. If this item must be selected always, it is treated as a mandatory feature (denoted as black circle, see Figure 3a), otherwise it is treated as an optional feature (denoted as white circle). Usually, the lowest-level UI represents a variant point with variants of alternative features as grouped features.

2. The navigation process is repeated in order to cover all paths by selecting the remaining functional items within each UI. Other features are extracted as it is described by step 1 and represented as the parent-child relationship tree (sub-tree).
3. The constraints of the type require or exclude (if any) are identified among variants, variant points or intermediate features. This activity is based on the knowledge of the analyzer (usually he/she is a designer of the system). The parent-child feature relationship tree combined with constraints is the functional FM (F FM) of $S_0$.

4. The system $S_1$ is analyzed next in a similar way having the F FM of $S_0$ as a basis for the $S_1$ F FM. This means that we need to add to the obtained model the only new features that appear in UIs of $S_1$.

5. Finally, the system $S_0$ is analyzed (having in mind the F FM of $S_3$ as the basis), but now adding the only new features from the UIs of $S_3$.

6. The BL FMs for the representative systems are constructed on the basis of F FMs by adding business logic features to the F FMs. The analyst needs to work partially at the code level in order to extract the implementation related knowledge such as modules and APIs. The BL FM (FMs) (an extract of the model is given in Figure 3a) serves for two purposes: 1) to evaluate the systems by model evaluation metrics (see 4.3 and 2) to construct meta-graph for the $S_0$ to understand it and the entire IS family from the user and designer perspective.

3.3 Metrics to Evaluate Feature Models

We introduce a feature model similarity metric (Eq. 2) expressed as the absolute value difference (AVD) adopted from (Arzoky et al., 2012). The obtained models are then compared and evaluated using the metric.

$$AVD(X,Y) = \sum_{i=1}^{s} \sum_{j=1}^{t} |x_{ij} - y_{ij}|,$$ \hspace{1cm} (2)

where $X$ and $Y$ are binary feature matrices of two comparable feature models for $S^{(m)}$, $x_{ij}$, $y_{ij}$ elements of the matrices; $s$ – is the number of features of the largest matrix. $x_{ij}$, $y_{ij}$ =1, if features $i$ and $j$ have the relationship or constraint branch; otherwise $x_{ij}$, $y_{ij}$ = 0. Note that the feature model with a smaller number of features is supplemented by additional void features (isolated nodes without branches) in order to equalize the size of both matrices.

To evaluate complexity of FMs, we use two measures (Štuikys and Damaševičius, 2013, see pages 213-216): cognitive complexity, which is calculated as the maximal number of feature levels in the hierarchy or the maximal number of features in each level, and the compound complexity (estimated by Eq. 3):

$$C_m = F^2 + (R_{mand}^2 + 2R_{op}^2 + 3R_{case}^2 + 3R_{c}^2) / 9,$$ \hspace{1cm} (3)

$C_m$ - compound complexity measure; $F$, $R_{mand}$, $R_{op}$, $R_{case}$, $R_c$ – the number of {all features, mandatory relationships, optional relationships, alternative relationships, relationships among variants including constraints}, respectively; the division coefficient is for equalizing the role of relationships. We present and analyze the estimated values obtained using Eq. 2 and Eq. 3 in Section 4.

3.4 Metagraph as a Model to understand Business Processes

The BL FM provides essential attributes to understand system functionality by designer well; however, the model is less helpful for understanding the user’s requirements because it may be too complicated for the user. For example, when the designer interacts with a user aiming to know his/her requirements as compared to those that are implemented into the already existing IS, all details of the model are not needed. On the other hand, the designer needs to communicate with the user using his/her language. Though feature names are usually expressed in the user-understandable fashion, the FM should be refactored and reduced. We introduce yet another (higher) level within FM; and we construct the higher-level model, called metagraph (Figure 3b). The intention of the metagraph is to specify sub-processes within BL expressed through sequences of features needed to perform the BL operations. The metagraph $G(X, (E, U^*))$ notation we have adopted from (Basu and Blanning, 2007) and apply it in our context as follows. Two nodes, denoted as $x_0$ and $x_i$ ($x_0 \neq x_i; x_0, x_i \in X$), represent the initial and final states respectively. All sub-processes begin at Start state and terminate at the End state (if the process that consists of a set of sub-processes is complete). A node $x_i \in X (i = [1, t – 1])$ represents the business sub-process. There are weighted and non-weights arcs.
weighted arcs \( u_{ij} = (x_i, x_j) \) \( (u_{ij} \in U; i, j \in [0, t]) \) represent the execution sequence of sub-processes and the weight \( w_{ij} \) represents a compound structure of features taken from Eq. 4, using BNF-like notation.

\[
w_{ij} = \{<\text{number_of_BL_features}>;\: [[<\text{FM_class_ID}>;\: <\text{set_of_class}> ;\cdot ;\cdot ];\cdot ];\cdot <\text{LOC}>\},
\]

where \(<\text{number_of_BL_features}>\) is the total number of features in the BL FM that are to be selected to execute a sub-process (e.g., the sub-process “Order details confirmation” requires 38, see Figure 3 b);

\(<\text{FM_class_ID}>;\: <\text{set_of_class}> \) is the BL FM category identifier with a set of features within each category (e.g., the sub-process “Order details confirmation” contains two categories of features PG and SL; the first has only one set of features (CAA4); the second category SL has 1 set of features (CA).

\(<\text{LOC}>\) - the number of code lines to implement the sub-process (e.g., 3057 for the same sub-process).

\([<x>]\) – list of \(<x>\) items.

The set \( E \) is the feedback arcs to define the sequence of sub-processes which return to the Start state in order to complete some task. Formally, the set is defined as: \( E = \{\forall_{k \in [1, t]} (x_{k}, x_{k+1})\} \), i.e. each sub-process has a feedback arc for returning to the initial state, if there is the need for terminating the sub-process (e.g., if the sub-process “Products catalogue” was executed to see the product category list only).

4. EVALUATION OF THE APPROACH AND EXPERIMENTS

We present the algorithm to solve the main task (Product purchase) using the constructed metagraph. The algorithm models the task solving through the identification of series of routes within the metagraph (see bold branches in Figure 3b) as follows:

1) From Start to Add to cart & return to Start; 2) From Start to Shopping cart confirmation & return to Start; 3) From Start to Order details confirmation & return to Start; 4) From Start to Order confirmation & to End.

The algorithm is simple enough to explain the meaning of business processes for the novice user of IS. If the user wants new features to be added to his/her IS, the model and the algorithm is helpful too, because it points to a particular part of FM to explain possible extensions of the system (i.e., to elicit new requirements). The model provides the designer with the extremely useful information to track FMs to introducing changes into code. Also, the designer is able to reason about the level of quality of the previously developed IS.
Furthermore, the model provides some information on modularization (it is clearly seen that the subprocesses, as a source for modularization, have a quite different number of features, meaning the *size problem of modules*: it is known that to support changeability, modules of the system should be approximately equal in size). The model is also beneficial to deal with the so-called *concept location problem* because designer is able to see features at high abstraction level, and then, to navigate through different levels of abstraction to select the needed code.

The results of experiments we have carried out also contribute to the understanding of the systems via the identified changes in functional similarity, and complexity growth. Three representative systems ($S_0$, $S_3$, $S_R$ identified as the initial, intermediate and the latest), within 7 years of their evolution, have been selected for investigation. Note that only the essential part of a system (identified as the user-based vision of a system) was used in the experiments (due to simplification of the process). We have identified the similarity and functionality changes of systems over the evolution period as compared to the initial system. Using AVD as a similarity measure (see Figure 4), we estimated (for the BL FM only) that the similarity evolved roughly linearly, though the number of systems delivered in the second half (3.5 years) of the total period was much higher. Figure 4 (see the right side) also provides with information on the code complexity changes (growth) that were measured by LOC. Again, only the essential part of representative systems was taken into account.

![Figure 4. Similarity and simplified BL FM complexity increase](image)

Evaluation of system complexity has been estimated at the model level, too. Results are summarized in Table 1, where several model complexity measures, such as cognitive complexity, structural and compound complexity, are given to identify the growth of complexity over time (*2nd Lehman’s Law*).

<table>
<thead>
<tr>
<th>Representative Systems</th>
<th>FM complexity measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of VPs</td>
</tr>
<tr>
<td>$S_0$</td>
<td>40</td>
</tr>
<tr>
<td>$S_3$</td>
<td>49</td>
</tr>
<tr>
<td>$S_R$</td>
<td>65</td>
</tr>
</tbody>
</table>

The benefits of models are: 1) reference system models are representative items of the entire IS family enable to reducing the space of variants in understanding them; 2) models cover the underlying functional attributes of the family; 3) similarity measures enable to observe the evolution of systems functionality growth and track the introduced changes over time; 4) metagraphs help to elicit new requirements.

## 5. CONCLUSIONS

As e-commerce systems (for small-to-medium enterprises) are evolving extremely rapidly, their maintenance and evolution tasks are complex and require essential effort to analyse and understand them. The understanding problem we have analysed is the primary step to improve maintainability of such systems. The models we have created using the methodology are beneficial for all actors involved in the process (including users trying to transfer their requirements for system innovations), though to the different degree. Though the methodology has been devised using a specific set of IS, we hope that it might be useful for a broader kind of
distributed systems. Outcomes give a good background for the next steps, such as refactoring to achieve better modularization and generalization of the components. The limitation of the approach is that the FM extraction is expert-oriented and metrics for FMs are not matured enough.

ACKNOWLEDGEMENTS

The work described in this paper has been carried out partially within the framework the Operational Programme for the Development of Human Resources 2007–2013 of Lithuania „Strengthening of capacities of researchers and scientists” project VP1-3.1-ŠMM-08-K-01-018 „Research and development of Internet technologies and their infrastructure for smart environments of things and services” (2012–2015), funded by the European Social Fund (ESF).

REFERENCES

UML CLASS DIAGRAMS – A COMPARATIVE STUDY ON APPROACHES TO FINITE SATISFIABILITY VERIFICATION

Paulo Bastos and Pedro Ramos
ISCTE-IUL – University Institute of Lisbon - Avenida das Forças Armadas, Lisbon, Portugal

ABSTRACT
Unified Modeling Language class diagrams are widely used for modeling, playing a key role in the analysis and design of information systems, especially in development contexts that use modeling oriented methodologies. Therefore, it is relevant to ensure the creation and maintenance of correct class diagrams. With the use of class diagrams it is possible to specify classes, relations and restrictions, however, such diagrams are subject to modeling errors made by their authors and may degenerate into incorrect diagrams. A common cause of incorrect diagrams refers to the definition of contradictory and inconsistent constraints, leading to finite satisfiability problems. Several approaches to the verification of finite satisfiability are currently available, supported by different tools. Through this work, we proceed with the identification and comparison of the existing approaches for the verification of finite satisfiability in class diagrams, determining the effectiveness and efficiency of the proposed tools.

KEYWORDS
Finite satisfiability, class diagrams, Unified Modeling Language.

1. INTRODUCTION
During recent years, Unified Modeling Language (UML) has emerged as a widely used standard in the analysis and design of information systems. UML is used to specify, visualize, construct and document the artifacts of an information system, providing itself as an essential analysis and modeling tool for system architects, engineers and software analysts (Rumbaugh, Jacobson and Booch 1999). Additionally, UML can also be used for modeling business process, modeling databases and also modeling software unrelated aspects. UML provides a set of diagrams that allow the representation of several aspects of an information system, however, the class diagram is the most used diagram with an adoption rate of 73% in projects that use UML for modeling purposes (Dobing and Parsons 2006). Considering the key role of modeling in the analysis and design of information systems, especially in modeling focused contexts, such as Model Driven Development and Model Driven Architecture, it becomes relevant to ensure the creation and maintenance of correct UML diagrams.

By using UML class diagrams, we can specify classes, their associations and constraints. However, these diagrams are subject to modeling errors by their authors and can degenerate into incorrect diagrams. Even with the use of Computer-Aided Software Engineering (CASE) tools to assist the process of modeling data, such does not prevent the creation of incorrect models, since CASE tools allow the creation of incorrect class diagrams. The creation of incorrect class diagrams causes several problems, which are related to different characteristics of UML models quality, such as coherence, correctness, completeness and consistency (Unhelkar 2005). The existence of problems in a class diagrams has an impact on the software development life cycle (SDLC), particularly when it relies on model dependent code generation methods.

This study focuses on a recognized problem in UML class diagrams: finite satisfiability (Berardi, Calvanese and Giacomo 2005). We are in presence of finite satisfiability problems when it is impossible to instantiate a class diagram. More formally, when its instantiation requires the existence of empty or infinite classes in order to satisfy the constraints present in the diagram (Balaban, Marae and Sturm 2010). Finite satisfiability problems occur due to inadequate designs, e.g., conflicting constraints. In presence of complex...
diagrams, conflicting constraints are sometimes near impossible to detect by humans. In data warehouse projects, when it is necessary to import data from multiple sources, conflicting constraints are also common.

The verification of finite satisfiability in class diagrams can be performed manually, however, due to the visual nature of the class diagram, it is a time consuming and error-prone operation. Additionally, current commercial CASE tools do not provide functionalities for the verification of finite satisfiability in UML class diagrams (Cadoli et al. 2007; Balaban, Maraee and Sturm 2010).

Through this study, we proceeded with the identification and comparison of approaches for finite satisfiability verification in UML class diagrams, with the objective of comparing the characteristics, advantages and disadvantages of the approaches, their effectiveness and efficiency, as well as determining which approaches and respective tools are most appropriate for finite satisfiability verification. By doing so, we offer a unique contribution to the existing literature in the field of finite satisfiability verification, which is scarce in comparative studies and practical usage scenarios. Additionally, the findings of this study provide a support guide for future users when choosing a tool for verifying finite satisfiability in UML class diagrams.

The paper is organized as follows: in section 2 we present and motivate the problem of finite satisfiability in class diagrams. In section 3 different approaches to finite satisfiability automatic verification are briefly presented. In section 4 we compare those approaches using a comparison framework defined by the authors. Some concluding remarks are presented in the last section.

2. FINITE SATISFIABILITY IN CLASS DIAGRAMS

A class diagram is a model abstraction of a real world scenario and it presents a visual representation of the structure of an information system. The main components of a class diagram are classes and associations (see Fig. 1). A class (1) describes a set of objects that share the same specifications, constraints and semantics, and it is defined by its name (2), attributes (3) and operations (4). From a class an object can be created, through a process named instantiation.

An association represents a relation between classes and it is defined by its role in the association (6) and its multiplicity (7). Multiplicity acts as a restriction, by defining the participation level of a class instance with the other class, i.e., the number of minimal and maximal objects allowed. Additional basic components of a class diagram are: binary association (5), n-ary association (8), association class (9), composition (10), aggregation (11), generalization (12) and generalization set (13). A detailed explanation of the class diagrams components and semantics can be found in the existing literature (Rumbaugh, Jacobson and Booch 1999; Booch, Rumbaugh and Jacobson 2005).

Finite satisfiability is one of the inherent characteristics in class diagrams correctness, which is an aspect of UML class diagrams quality. A finite satisfiability problem is a symptom of an error that occurred in the analysis phase of software development (Cadoli et al. 2007), usually caused due to conflicting constraints.
specification that impose multiplicity requirements that can only be satisfied by empty or infinite classes. Naturally, a diagram that can only be instantiated using empty or infinite classes does not have any practical use.

A class is considered finitely satisfiable if it has a non-empty extension in a legal finite instance. A class diagram is considered finitely satisfiable if all classes are finitely satisfiable (Balaban, Marae and Sturm 2010). A legal instance refers to an instance of a class diagram where all classes and associations meet the restrictions of the diagram, i.e., there is no violation of the restrictions. The verification of finite satisfiability is relevant in the context of software applications and databases, since the number of instances is intrinsically finite. In order to illustrate a diagram with a finite satisfiability problem, consider the example in Fig. 2.

![Diagram of a UML class diagram with a finite satisfiability problem](source: Figure adaption from Cabot, Clarisó and Riera 2008)

This model is considered finitely unsatisfiable. The multiplicity of the association Reviews mandates that exactly three student review a paper, however, the multiplicity of the Writes association, simultaneous mandates exactly one student as an author of a paper. One might imagine the instantiation of this model and verify that the instantiation of an object of the class Paper would generate three objects of the class Student, which by them self would generate newer Paper objects and subsequently new Student objects, in an infinite process. Since only an infinite or empty instantiation may satisfy both constraints simultaneously, it is said that this diagram presents a finite satisfiability problem and it is finitely unsatisfiable.

Additional examples of finite satisfiability problems can be found in the existing literature (Balaban, Marae and Sturm 2010; Cabot, Clarisó and Riera 2008; Cadoli et al. 2007).

The occurrence of finite satisfiability problems during the analysis phase of the software development life cycle generates errors that would only be found during the execution of the software, which as a large impact on the reliability of software systems. Therefore, it is relevant to assure that a class diagram is finitely satisfiable, especially in large scale system development environments that recur to modeling focused methodologies or critical software systems.

### 3. APPROACHES TO FINITE SATISFIABILITY VERIFICATION

Considering the importance of class diagrams and the need to produce models with quality, it becomes relevant the existence of additional functionalities to CASE tools, in order to provide methods for reasoning in UML diagrams and identify potential problems (Berardi, Calvanese and Giacomo 2005; Cadoli et al. 2007; Balaban, Marae and Sturm 2010). Several studies have been performed in order to obtain answers to the problem of finite satisfiability in UML class diagrams. Currently, there are several approaches to the subject, which involve the use of different tools. The set of approaches referred in this comparative study are identified by their respective tool in Table 1.
Table 1. Approaches to the verification of finite satisfiability

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>Approach based on the translation of UML/OCL class diagrams for a logical representation, upon which deductive databases query containment tests are applied.</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>Approach based on the use of methods of reasoning in terms of logic description for the transformation of class diagrams into constraint satisfaction problems.</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>Evolution of the UMLtoCSP approach, adapted to consider the EMF modeling system.</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>Approach by linear programming, based on the transformation of class diagrams in linear inequalities systems.</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>Approach based on the transformation of UML/OCL class diagrams in constraint satisfaction problems, using the syntax provided by the ECLiPSe Constraint Programming System.</td>
</tr>
</tbody>
</table>

Current solutions for the verification of finite satisfiability employ different formalisms, such as linear programming (Maraee and Balaban 2007), deductive databases query containment tests (Queralt and Teniente 2006) and constraints satisfaction problems (Cabot, Clarisó and Riera 2008; Cadoli et al. 2007).

The AuRUS approach consists in the transformation of conceptual schemes to a logical representation, in which classes, attributes and associations are transformed into basic predicates, while cardinality constraints are transformed into formulas, as to specify the conditions that must be met. After the transformation, the Constructive Query Containment (CQC) method is applied. The CQC method makes use of query containment tests in order to perform the verification of finite satisfiability (Queralt et al. 2010).

The FiniteSatUSE approach converts class diagrams into linear inequalities systems, which define the multiplicity restrictions present in the diagram. If a solution is found for the linear inequalities systems, it is said that the diagram is finite satisfiable. Otherwise, it has a finite satisfiability problem. This approach also makes use of detection graphs in order to find the cause of finite satisfiability problems, when a problem is detected (Maraee and Balaban 2007).

The EMFtoCSP, CCC/EinaGMC and UMLtoCSP approaches use the same formalism, sharing a common base approach through the use of constraint satisfaction problems. By using the constraint programming paradigm, a class diagram is converted into a constraint satisfaction problem, with each element being translated into a set of variables, domains and constraints. If a solution for the constraint satisfaction problem is found, it is said that the class diagram is finitely satisfiable (Cabot, Clarisó and Riera 2008).

The EMFtoCSP and UMLtoCSP approaches support the transformation of diagrams containing OCL restrictions and make use of the syntax provided by the ECLiPSe Constraint Programming System to express the constraint satisfaction problem. The CCC/EinaGMC approach does not support OCL restrictions.

Some approaches have resorted to the creation of specific tools for this purpose, while others use existing tools or implement features to existing tools in the form of plugins. The AuRUS tool is available through the Internet as a java applet application, CCC/EinaGMC as a plugin for the EinaGMC IDE tool, EMFtoCSP and UMLtoCSP as a plugin library for the Eclipse IDE. The FiniteSatUSE tool is implemented as a standalone tool, although it makes use of core classes of the USE tool. Regardless of the used implementation resource, most of these tools still show several limitations and there is not a record of the use of these tools in a professional environment.

4. COMPARATIVE STUDY

Due to the embryonic state of the subject, at the time, there is no comparison framework for comparing tools of this nature. Thus, a set of comparison criteria’s was compiled and defined by the authors, creating a comparison framework. The comparison criteria’s and guidelines used in this comparative study were defined by adopting criteria’s suggested in the literature (Cabot and Clarisó 2005), similar comparison studies for different tools and concepts (Shaikh, Wiil and Memon 2011) and CASE tools selection guides (ISO 1995). The characteristics defined for comparison are grouped into six distinct groups of classification and comparison: problem addressing, completeness, essential characteristics, UML support, effectiveness and efficiency. These comparison characteristics are explained in 5.1.
In order to perform the comparative tests, a set of UML class diagrams was prepared. The authors opted for the use of class diagrams of the Common Information Model (CIM), provided by the Distributed Management Task Force (DMTF). The CIM consists of a set of UML class diagrams that provides the definition of management information for systems, networks and applications, ensuring standardized use throughout the industry. To cover the intended test scenarios, several adaptations where performed, for the range of dimension desired (considering the number of classes, associations and attributes). There was also some adulteration of the diagrams, through the purposely insertion of errors that originate finite satisfiability problems.

As such, a set of diagrams was adapted, consisting in 3 different dimensions and different numbers of finite satisfiability problems. Regarding the dimension, the smaller diagram is a simple diagram with 2 classes, followed by a medium sized diagram with 9 classes and the larger diagram is composed of 32 classes. Comparison testing with larger diagrams is already been considered for future work.

4.1 Comparison Results

The problem addressing criteria refers to three levels of problem reasoning, as defined by Hartman (2001): the detection of the problem (C1.1), the identification of the cause (C1.2) and the suggestion of a solution (C1.3). Problem detection relates to the ability of the tool to issue a notification when in the presence of a problem. Cause identification relates to the ability to identify the source of the problem. Solution suggestion refers to the ability to advice a solution to correct the error that originates the finite satisfiability problem.

<table>
<thead>
<tr>
<th>Tool</th>
<th>C1.1 - Ability to determine that a problem exists?</th>
<th>C1.2 - Ability to identify the cause of the problem?</th>
<th>C1.3 - Ability to suggest a solution to the problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

As shown by the results, the approaches embodied by the tools EMFtoCSP, FiniteSatUSE and UMLtoCSP offer the ability to detect the existence of finite satisfiability problems and indicate the cause of the problem. The AuRUS and CCC/EinaGMC tools are only able to indicate the existence of problems, but not the cause. Currently, no tool provides the ability to suggest a solution to the problem. The absence of this functionality is not resultant of a lack of technical implementation, but an omission present in all the approaches. However, the FiniteSatUSE team is currently undergoing investigation regarding this particular capability, through the use of a pattern-based approach for providing explanations and solution advices (Balaban, Maraee and Sturm 2010).

Through the completeness comparison, we determine which approach offers a more complete solution. Thus, the compared characteristics refer to the ability to identify more than one finite satisfiability problem (C2.1) and the ability to present a proof of finite satisfiability when a class diagram does not have finite satisfiability problems (C2.2).

<table>
<thead>
<tr>
<th>Tool</th>
<th>C2.1 - Ability to identify multiple problems?</th>
<th>C2.2 - Ability to present proof of finite satisfiability?</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The AuRUS and CCC/EinaGMC tools failed to identify the existence of more than one finite satisfiability problem. These tools only provide a feedback regarding the finite satisfiability of the class diagram, regardless of having just one problem or more problems. Contrarily, the EMFtoCSP, FiniteSatUSE and UMLtoCSP are able to provide information about the existence of more than one finite satisfiability problem.
Regarding the proof of non-existent problems, only the EMFtoCSP and UMLtoCSP tools comply with this feature, suggesting an object diagram, which represents a possible instance of the class diagram satisfying all constraints and, therefore, finitely satisfiable.

The essential characteristics comparison mainly refers to a set of characteristics that are regard as essential for a finite satisfiability verification tool (Cabot and Clarísó 2005). These characteristics include the ability to: accept an input perceptible by the user (C3.1) and commonly accepted (e.g. UML/OCL), analyze the diagrams as they are, without requiring additional annotations (C3.2), verify automatically, without the manual interaction of the user (C3.3), provide understandable results (C3.4) and integrate effortlessly in the SDLC (C3.5), without the need of additional time consuming steps.

Table 4. Comparison results of essential characteristics

<table>
<thead>
<tr>
<th>Tool</th>
<th>C3.1 - Accepts as an input a notation understandable by the user?</th>
<th>C3.2 - Ability to verify without additional annotations?</th>
<th>C3.3 - Automatic verification capability, without user interaction?</th>
<th>C3.4 - Provides understandable results for the user?</th>
<th>C3.5 - Integrates effortlessly in SDLC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Regarding the ability to accept a perceptible and commonly used input, only the FiniteSatUSE was considered as not able, because of the use of USE grammar. The use of this tool implies the conversion of the UML class diagrams to USE grammar. Despite the existence of a prototype conversion tool from XMI to USE grammar (Sun et al. 2009), it was not possible to use it with success and some manual conversion work was necessary. It was observed that all tools were able to verify the diagrams without the use of a specific additional annotation, without user interaction and the results were perceptible and understandable. The FiniteSatUSE tool was considered as not able of effortlessly integrate in the SDLC due to the conversion problem already addressed, which involves a time consuming and error prone additional step in contrast to the other tools.

The UML support comparison was defined in order to verify which tools support the most common components present in UML class diagrams. Accordingly, it was verified if the approaches and respective tools supported: binary associations (C4.1), associations n-ary (C4.2), associative classes (C4.3), aggregation (C4.4), composition (C4.5) and generalization (C4.6).

Table 5. Comparison results of UML support

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The AuRUS and FiniteSatUSE tools do not support n-ary relations. The EMFtoCSP and UMLtoCSP tools do not support aggregation and composition. Note that this support refers mainly to the loading of the class diagram, rather than the verification process.

The effectiveness comparison refers to two dimensions: the ability to verify a diagram according to the number of problems and the ability to verify according to the dimension of the diagram. Thus, it was defined comparison criteria’s to verify the successful verification in diagrams without problems (C5.1) with only one problem (C5.2) and with more than one problem (C5.3). Additionally, it was verified the success of verification in diagrams with different dimensions (C5.4, C5.5 and C5.6). The dimension specifications refer to the number of classes, attributes and associations of the diagrams. Results show that all tools are effective when verifying diagrams, independently of the number of problems in the diagram. This comparison criteria
refers only to the capacity for verifying the diagram and not the fact of being able to indicate the existing problems, as this feature had been tested previously (C2.1).

Table 6. Comparison results for effectiveness

<table>
<thead>
<tr>
<th>Tool</th>
<th>C5.1 – Verification with 0 problems?</th>
<th>C5.2 – Verification with 1 problem?</th>
<th>C5.3 – Verification with 1+ problems?</th>
<th>C5.4 – Verification of N_{class} \approx 2, N_{assoc} \approx 1, N_{attrib} \approx 5 diagrams?</th>
<th>C5.5 – Verification of N_{class} \approx 10, N_{assoc} \approx 5, N_{attrib} \approx 25 diagrams?</th>
<th>C5.6 – Verification of N_{class} \approx 30, N_{assoc} \approx 20, N_{attrib} \approx 100 diagrams?</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The comparison regarding the verification of diagrams of different dimensions showed some differences between tools. While all tools have been able to load and check the smaller dimension diagrams (C5.4 and C5.5), the AuRUS and CCC/EinaGMC tools did not succeed in checking the larger dimension diagram (C5.6). However, it was not possible to determine whether the failure is related to a weak technical capacity of the tool for manipulating larger diagrams or an actual limitation of the verification process.

The comparison of the efficiency refers to the time necessary for the verification of finite satisfiability problems in diagrams of different dimensions. The measure is presented in seconds and represents the average value of three consecutive runs.

Table 7. Comparison results for efficiency

<table>
<thead>
<tr>
<th>Tool</th>
<th>C6.1 – Verification time of N_{class} \approx 2, N_{assoc} \approx 1, N_{attrib} \approx 5 diagrams?</th>
<th>C6.2 – Verification time of N_{class} \approx 10, N_{assoc} \approx 5, N_{attrib} \approx 25 diagrams?</th>
<th>C6.3 – Verification time of N_{class} \approx 30, N_{assoc} \approx 20, N_{attrib} \approx 100 diagrams?</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuRUS</td>
<td>5 s</td>
<td>203 s</td>
<td>-</td>
</tr>
<tr>
<td>CCC/EinaGMC</td>
<td>&lt; 1s</td>
<td>107 s</td>
<td>-</td>
</tr>
<tr>
<td>EMFtoCSP</td>
<td>&lt; 1s</td>
<td>112 s</td>
<td>3105 s</td>
</tr>
<tr>
<td>FiniteSatUSE</td>
<td>&lt; 1 s</td>
<td>78 s</td>
<td>2720 s</td>
</tr>
<tr>
<td>UMLtoCSP</td>
<td>&lt; 1 s</td>
<td>102 s</td>
<td>3010 s</td>
</tr>
</tbody>
</table>

Regarding the verification of the smaller dimension diagram (C6.1) with the exception of the AuRUS tool, all verification times are less than 1 second. The higher time of the AuRUS may be affected by the fact that this tool is provided through the Internet and subject to inherent network limitations. The verification of the medium-sized diagram (C6.2) presented times from 78 seconds to 203 seconds. The verification of the larger diagram (C6.3) presented a considerable increase of time required to perform the verification, with time values near the 3000 seconds mark. Concerning the AuRUS and CCC/EinaGMC tools, it was not possible to determine the processing time, since these tools were unable to process the diagram.

5. CONCLUSION AND FUTURE WORK

Upon the completion of the comparative study and the analysis of the results, some conclusions can be reached, as well as some additional considerations by the authors. Although most available approaches still have some limitations, it was found that most approaches and respective tools can detect with success the existence of finite satisfiability problems in UML class diagrams.

Taking in account the results of the comparison study, the authors consider the following tools to be the most suitable for the verification of finite satisfiability: EMFtoCSP, UMLtoCSP and FiniteSatUSE. This conclusion takes mainly in account the ability for verifying large diagrams, as well as the capability for identifying more than one finite satisfiability problem and respective causes of the problems. The EinaGMC and AuRUS tools, although considered less suitable, may be recommended for specific scenarios where one only needs to validate the finite satisfiability of small diagrams.

Note that the findings and conclusions reflect the current state of the tools at the time of this work. As most of these tools exist in a prototype mode and are in a permanent state of evolution and development, it is...
correct to assume that some negative results may be due to the referred permanent state of evolution and it is possible that the repetition of this comparative study in a near future would provide different results. Additionally, the authors consider that, due to the current state of the art regarding finite satisfiability verification tools and the lack of studies that may indicate significant advantages of adopting the verification of finite satisfiability in the software development life cycle, one should not expect a near future adoption of these tools in professional environments.

In future work, the authors intend to enrich the comparison framework, by defining quantitative scales and new comparison criteria’s, recurring to a joint survey of researchers and specialists in finite satisfiability. By doing so, the authors aim to create a universally accepted comparison framework, used for future comparison and benchmark studies. The authors also intend to pursue studies regarding the impact and acceptance of finite satisfiability verification tools in real work environment.

ACKNOWLEDGEMENT

We would like to acknowledge and extend our gratitude to the following persons, who have helped or contributed in some way to this study: Prof. Mira Balaban, Prof. Dr. Lars Hamann, Prof. Ernest Teniente, Prof. Song Eunjee and graduate student Xiyan Cao.

REFERENCES


LEAVING THE HAPPY PATH:
HANDLING EXCEPTIONS IN BUSINESS PROCESSES

Matthias Kurz\textsuperscript{1}, Matthias Lederer\textsuperscript{2} and Sebastian Huber\textsuperscript{2}
\textsuperscript{1}Datev eG - Fürther Str. 28, 90429 Nuremberg, Germany
\textsuperscript{2}Institute of Information Systems, University of Erlangen-Nuremberg - Lange Gasse 20, 90403 Nuremberg, Germany

ABSTRACT
Traditional business process management successfully focuses on standardized business processes which are performed according to a fixed predefined process model. Yet a substantial share of business processes is difficult to predict with exceptions to the core processes occurring frequently. This contribution proposes to explicitly consider exceptions and handle them according to their degree of standardized behavior. A methodology comprising two main components provides guidance for this new perspective on exceptions: (1) a classification details the types of exceptions that are encountered in real-world BPM projects. (2) An approach inspired by the exception handling mechanisms in software engineering advises methods and tools for handling the exception types and suggests a corresponding escalation mechanism. Both the classification and the procedure model are evaluated by ten domain experts.

KEYWORDS

1. INTRODUCTION
The term \textit{exception} is used in many areas of science and business practice. In general, an exception is rooted in the fundamental phenomenon that pre-planned operations, processes (Antunes, 2011), business planning (Milliken, 2011), or program logic is modified or disturbed due to unexpected events. In the context of business process management (BPM), exceptions are often described as being a particularly common phenomenon (Saastamoinen et al, 1994), however, currently employed methodologies, IT systems and procedure models seem inadequate for their effective and efficient management. This research gap gains importance by analyzing the economic relevancy of exceptions: the management of process exceptions is known as particularly resource-binding, cost-intensive (Sadiq and Orłowska, 2000), success critical (Casati et al, 1999), as well as time-consuming.

For illustrating the research findings and later on for validation purposes, four classic example scenarios are introduced. These are: (1) a customer configures a complex product (e.g., a car) and orders it online. After his/her order request, the customer changes the order and, depending on the advanced production process, this change causes an exception. (2) In the check-out process at a hotel reception, a customer is dissatisfied with the performance obligations. Dealing with this customer raises an exception, since the standard complaint process is not sufficient for an aggressive customer. (3) A customer's online order includes shipment to his/her home address. Since the supplied product properties could not satisfy him/her, he/she returns the good. (4) An online shop delivers its goods by using a parcel service to a consumer. Due to an accident at the parcel's site, the goods get lost.

The relevance of exceptions has already been investigated qualitatively and quantitatively in various sources (Milliken, 2011; Saastamoinen et al, 1994; Saastamoine, 1995; Eder and Liebhart, 1995). One major challenge in BPM is the question how to deal with unforeseen events that have impact on the way a process is being executed. Most of the current solutions allow these changes only during design-time. This leads to the problem of how to redevelop a changed process model and update currently running process instances. For unique or rarely occurring exceptions it is not required to change the base process. Instead an approach allowing dynamic reactions to unpredicted exceptions is required. Yet, before developing such an approach, it is necessary to identify the types of exception this approach has to handle.
2. EXCEPTION CLASSES

Literature and studies suggest various attributes of exceptions and their possible values. For example, (Saastamoinen et al., 1994) proposes a very comprehensive model with a list of attributes (e.g., origin of exception-triggering events) and enumerates their possible values (e.g., market, organization, technology) which exceptions can follow. However, for the goal of this research these bare lists are not sufficient. Rather, a basis for the new handling approach must be generated with a schema, in which exceptions are grouped into generic classes. These classes should be created based only on the most elementary attributes. This way, the exception handling strategies can be derived from the classes.

<table>
<thead>
<tr>
<th>Existing theories</th>
<th>Exception types from (Saastamoinen and White, 1995)</th>
<th>Established exception</th>
<th>Otherwise exception</th>
<th>True exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attributes</td>
<td>Predicted</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Unpredicted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Formal behavior</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Informal behavior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resulting classes</td>
<td>Normal process execution</td>
<td>Routine exception</td>
<td>Minor exception</td>
<td>Major exception</td>
</tr>
</tbody>
</table>

Table 1. Development of exception classes

Table 1 aggregates four fundamental classes of behavior based on the work of (Saastamoinen and White, 1995) and (White, 1995).

**Normal process execution**: This type of process specification is also called happy path. The happy path defines the allowed process executions assuming that no extraordinary events “disturb” the process. An example for the normal process execution is a customer ordering some products without any special events like changing the order or complaints about the delivery.

**Routine exceptions**: This type of exception is predictable and necessary handling operations can be defined in advance. In the above-mentioned order process, an example for routine exceptions is a customer changing his order after submission.

**Minor exceptions**: Exceptions of this class are predictable, but their handling is not planned in advance. The handling of exceptions is therefore organized ad-hoc and may only follow a rough schedule without detailed handling models. For these exceptions, the triggering events are known events but the reaction to these events is not strictly defined. In the example process, a customer complaining about the delivery is an event that is known. Yet due to the great variety of reasons leading to this complaint, the reaction is not defined in detail.

**Major exceptions**: Exceptions of this class can neither be predicted nor predefined. Concrete measures are taken after the occurrence of an exception on an ad-hoc basis, as the triggering events are unknown and can be caused by unknown actors from the environment. In the previously discussed order process, a customer filing a legal action against the company due to allegedly defective merchandise would be a major exception.

3. EXCEPTION HANDLING APPROACHES

The easiest class of exceptions to deal with is routine exceptions. They can be considered already at build-time. For major exceptions process variants are a suitable solution. In this way a new process model is developed for every exception (Gottanka and Meyer, 2012). This may lead to a large repository of process variants for the same main process. An alternative is having one base variant and adapting it manually at instantiation time. The approach of process variants is supported by common workflow management systems (WFMS) (Huth et al., 2003).

For responding to minor exceptions, the concept of process fragments is currently on the rise (Eberle et al., 2009). The idea is to provide small workflow pieces that could be dynamically combined at runtime. This
results in more flexibility to react to unforeseen circumstances even if the process is currently being executed. Ad-hoc workflow management systems (AWFMS) provide the corresponding IT support.

The ad-hoc sub-processes of the Business Process Model and Notation (BPMN) introduce a similar functionality (OMG, 2011). This notation allows encapsulating tasks and sub-processes without specifying all temporal and/or logical relations between them. Instead, it is possible to select the most appropriate path during execution. This helps to reduce the number of gateways in a process model. Furthermore, BPMN provides explicit notational elements for triggering and handling exceptions. This allows separating the normal process execution from the handling of exceptions.

WS-Business Process Execution Language (BPEL) is a widely used XML-based language for describing and automating business processes which orchestrate web services. BPEL uses a fault mechanism in order to signal exceptional situations (OASIS, 2007). This mechanism closely resembles the exception scopes used in modern programming languages. Exception scopes are introduced in section 0.

The business rules approach (BRA) has the goal to reduce the complexity of the process model. By externalizing complex decisions to a separate layer, the underlying process model can be standardized and reused for different execution scenarios. However, to fully automate processes, business rules are often implemented directly in the code base and the process models respectively.

In contrast to the already depicted methods, Adaptive Case Management (ACM) follows a different approach than the WFMS and BRA approaches which rely on responses that are defined during build-time. The main goal of ACM is to provide flexibility at runtime (Kurz and Herrmann, 2011). This allows reacting to unpredicted exceptions. The downside of the freedom given is the restricted ability to monitor the unstructured process and assess the case performance. In addition, ACM provides case templates that predefine the default case structure and provide a procedure model for incorporating new case developments in the respective templates (Kurz and Herrmann, 2011).

Exceptions and their handling are not only a topic in BPM. This is a typical challenge in Software Engineering as well. The easiest form of exception handling is conditional programming. It is comparable to the gateways used in eEPC, where a different branch of the control flow is considered for each process variant. However, conditions indicating exceptional situations (return codes in Software Engineering) have to be checked after each step that may potentially lead to exceptions. Using these gateways is similar to the use of so-called jump labels (goto) in programming languages like BASIC. This approach to deal with exceptions leads to so-called spaghetti code that is very hard to maintain and prone to errors (Dijkstra, 1968). To avoid this, the structured programming paradigm emerged (Dijkstra, 1968). It aims to improve the clarity, quality, and development time by making extensive use of subroutines, block structures and for and while loops.

In most cases the software should resume when an exception occurs. Therefore, a common approach for tackling this issue is to define an exception scope, within which an exception may occur. Once the exception is handled accordingly, the program flow continues at the end of the specified exception scope. One problem that needs to be covered is the possibility of an inconsistent program state due to the exceptions. With design by contract, requirements can be defined that have to be ensured after exception handling has been completed. This problem of inconsistent states is aggravated if multiple exceptions are raised at the same time (exception synchronicity).

4. PROPOSED EXCEPTION HANDLING APPROACH

The proposed approach aims at maximizing the automation degree of business process execution while ensuring that the necessary degree of flexibility is provided whenever necessary. In order to archive this objective, the approach consists of the following components:

- The so-called happy path is a process without integrated exception handling mechanisms. This allows for simpler and more straightforward processes.
- For each of the exception classes identified in section 2, a corresponding exception handling mechanism is proposed. These mechanisms support the respectively required degree of flexibility while ensuring as much guidance and standardization as possible.
- The procedure model details how and when to switch between the exception handling mechanisms.
- Exception scopes ensure that the flexible exception handling mechanisms can be finalized and the happy path can be resumed.
According to (Borgida and Murata, 1999) and (Mourao and Antunes, 2005), there are three functions of exception management in BPM: (1) exception detection, (2) situation diagnosis and (3) exception handling. This contribution focuses on exception handling, as this appears to be the most pressing aspect for practitioners (cf. section 5).

4.1 Happy Path

The key idea of the proposed approach is to distinguish between the typically executed business process (the so-called happy path (Silver, 2011)) and the handling of exceptions that may or may not occur during this process. This distinction allows for simpler and more straightforward processes that leave out unnecessary complexity for handling potentially only rarely occurring processes. Such a distinction between normal execution and the handling of exceptional situations is a well-used concept in software development (Gosling et al, 2012; Stroustrup, 1994). Separating the normal program flow and exception handling routines is a well-understood and widely used technique for cleaner software design (Goodenough, 1975). Externalizing certain aspects of a process model is considered a good design practice in BPM as well: the business rules approach separates process models and complex business rules controlling the execution flow of business processes (Halle and Ross, 2001). With automation being one of the key objectives, the simplified process model (the happy path) is best supported with classical BPM automation instruments like WFMS or enterprise resource planning (ERP) systems.

4.2 Exception Handling Mechanisms

Section 2 identifies three elementary classes of exceptions with an increasing degree of required flexibility for handling these exceptions: (1) routine exceptions, (2) minor exceptions, and (3) major exceptions. With maximizing the automation degree while ensuring sufficient flexibility being the key objective, the approach defines separate mechanisms for defining these exceptions.

As both the occurrence and the handling can be predicted for routine exceptions, this class of exceptions is best handled with classical BPM instruments, like e.g., the modeling with BPMN or XPDL (XML Process Definition Language) for the later execution in WFMS. This way, a potentially large number of routine exceptions will not contribute to the complexity of the process model, yet still can be handled accordingly.

While both routine and minor exceptions can be predicted, the handling of the latter exception class cannot be completely predefined. This eliminates classical BPM approaches like workflow management. AWFMS appear to be an adequate solution. Yet due to the formal requirements for introducing ad-hoc changes, AWFMS are too complex for everyday use. The ACM approach proposed by (Kurz and Herrmann, 2011) extends the ACM approach of (Swenson, 2010) and strives to support knowledge-intensive highly flexible business processes by relying on a task- and document-centric paradigm (Kurz and Herrmann, 2011) that requires less formalisms than classical WFMS or AWFMS. Due to its focus on knowledge-intensive highly flexible business processes, the ACM approach appears to be a viable candidate for handling minor exceptions. Yet, the ACM approach described in (Swenson, 2010) is more a set of ideas than a coherent methodology. Therefore, the refined exception handling mechanism for minor exceptions relies on the refined ACM derivate described in (Kurz and Herrmann, 2011). This derivate uses an (optionally hierarchical) task list for representing the case handling approach and takes a document-oriented perspective that is particularly geared toward knowledge-intensive processes. By defining templates that can be freely adapted to the respective needs, the exception handling can be standardized while providing the possibility for arbitrary ad-hoc changes. Beyond that, standardization efforts regarding the modeling of the case structure are already underway such as the Case Management Modeling and Notation (CMMN) project, initiated by the Object Management Group.

Major exceptions are not predicted and therefore cannot be planned in advance. In this case, the refined ACM approach can only provide a very generic template. Ultimately, such exceptions can only be handled by humans collaboratively. Therefore, the IT support in that domain focuses on the provision of fundamental collaboration platforms, like e.g., Microsoft SharePoint.
4.3 Procedure Model

The procedure model depicted in figure 1 provides a guideline of how to handle the three types of exception classes. The typical process execution flow is defined by the happy path. Whenever an exception occurs, one of the following basic three exception handling strategies is invoked.

**Workflow-based exception handling** (used for routine exceptions) is adequate for exceptions that can be resolved in a standardized manner. This level of standardization allows for automation using WFMS. While this appears to resemble the commonly used strategy of directly integrating exceptional process paths in the process model (cf. section 3) and thereby relying on a technique that is also known as spaghetti code in software development (cf. section 3), this mechanism actually relies on the idea of simplifying the core process model by externalizing parts of the process model. The business rules approach employs the same basic principle (cf. section 3). A typical example illustrates the mechanism: The order-to-payment process is the key process for online shops and therefore constitutes a typical happy path. With customers returning goods on a regular basis, the shop owners are well advised to automate these return processes using workflow management systems (or a corresponding function the online shop software provides). Separating this (automated) exception from the happy path ensures that the afore-mentioned order-to-payment process contains no unnecessary complexity due to “spaghetti exception handling”.

**Template-based exception handling** (used for minor exceptions) addresses scenarios where the exception can be predicted, yet the process of resolving this exception involves too much flexibility and therefore cannot be economically handled by a workflow-like approach. However, templates can provide the knowledge workers entrusted with resolving the exception in the form of guidelines. By utilizing the ACM approach, these templates contain prototypical exception handling processes that may be freely adapted during runtime (ad-hoc) according to the individual situation surrounding an exception. While the intentionally low granularity of the templates makes automation using WFMS impossible, these templates still provide best practices and guidelines for dealing with the exception at hand. Providing templates with a higher level of granularity is theoretically possible in ACM. Yet, this will defeat the purpose of ACM in this scenario, as a substantially higher degree of granularity will reduce the knowledge workers’ ability of adapting the template during runtime. In the above-mentioned web shop scenario, the template-based approach is an adequate candidate for resolving delivery issues (e.g., deliveries claimed to be lost). While the template processes ensure that these issues are resolved in a consistent manner, the knowledge workers have sufficient flexibility for resolving this issue (e.g., they may simply send another package without waiting for an explanation from the delivery company when it is certain that the delivery issue is not the customer’s fault, or in cases where the satisfaction of the individual customer at hand is vital for the continued success of the business).

**Collaborative exception handling** (used for major exceptions) allows handling unpredicted exceptions which cannot be planned ex ante. Therefore, experienced knowledge workers have to devise individual approaches for resolving this exception class. Groupware systems can substantially improve the collaboration and knowledge sharing between these knowledge workers. An example for this class of exceptions is a rare technical malfunction in the web shop software that makes the customers unsure whether their payments have been received or not. In this case, the web shop has to devise a solution for both solving the technical problem and communicating the status or solution to the customer. A groupware system will assist both the technical personnel as well as the spokesperson in assessing the situation and coordinating the next steps. Whenever a predicted exception occurs, the system responsible for the execution of the happy path (typically enterprise resource planning or workflow management systems) determines whether a workflow-based or template-based exception handling mechanism exists and initiates this mechanism. If no such mechanism is found, the collaborative – and most flexible – mechanism is invoked. During exception handling, it may become apparent that the currently followed exception handling mechanism is inadequate. In these cases, it is possible to escalate to an exception handling mechanism with a higher degree of flexibility. An example illustrates this: during the handling of the returning goods exception using the workflow-based approach, it becomes apparent that the returned goods are defect. As the customer claims that the delivery company is responsible, the exception cannot be handled by the workflow-based approach. Thus, it is necessary to fall back to the more flexible template-based mechanism.
4.4 Exceptions Scopes

Whenever exceptions have been handled, the process flow in the happy path can be resumed at any other state. Therefore, the exception handling approach has to provide “reentry points” in the happy path after an exception has been handled. This approach builds upon the exception handling mechanisms employed in software engineering, where parts of code are grouped together that can be handled separately in case of an exception (Dony, C. et al, 2006). Consequently, the happy path is also divided into several exception scopes. Once an exception is raised and handled, the execution flow resumes at the end of this exception scope (cf. figure 1). When defining such reentry points, it has to be ensured that exceptions or exception handling do not lead to inconsistent process states. For example, when an exception occurs in the order-to-payment process of a web shop before sending the goods, it must be ensured that the customer is not billed. This is particularly important for template-based and collaborative exception handling mechanisms, as these mechanisms rely on human interaction and therefore cannot utilize formal mechanisms for guaranteeing consistent process states. Therefore, each exception scope needs to define consistency requirements that need to be ensured whenever an exception scope is completed (be it on the happy path or be it due to a raised exception). The exception handlers resolving exceptions need to ensure that they consider the consistency requirements defined for the exception scopes. Typically, exception handlers have to undo changes made during activities within the exception scope before the exception occurred in order to ensure that the process leaves a consistent state. For this purpose, the system supporting the process execution has to provide undo mechanisms like transactions or compensation. With human work outside the used software system is a key element of the template-based and collaborative exception handling mechanisms, compensation is be a more realistic strategy for ensuring consistency than relying on transactions.

5. EVALUATION BY EXPERTS

With the two key contributions being a classification of exceptions and a corresponding approach for handling these exceptions, the evaluation of the findings comprises two phases. The validation by experts followed in each phase a four-step approach consisting of the presentation of each result and the collection of assessments of ten experts in semi-structured interviews. Then the statements were coded and analyzed in order to build up evaluation categories and to identify patterns.
In the first phase, both the relevancy of the topic as well as the exception classification were validated during ten semi-structured qualitative interviews with experts from the domains IT-enabled business process management and software engineering. To ensure the reliability of the evaluation, the experts were selected according to their years of experience in at least one of the two fields. The experts had to demonstrate at least five years of experience. In average, the experts had eight years of experience. The interviews started with questions that elaborated the role of exceptions in the day-to-day business processes they encountered as part of their responsibilities (e.g., ratio of process instances creating an exception and necessary efforts for exception handling). In the next step, the interviewees were asked to name and evaluate existing methods for exception handling. By requesting two more real-world scenarios for exceptions in BPM from each expert, it became possible to determine whether the classification was applicable for scenarios the authors were unfamiliar with. For instance the experts provided exception scenarios from documented processes in the health industry, from order processing in a call center, from design procedures of a textile manufacturer as well as from software maintenance. The experts unanimously confirmed the relevance of the topic at hand. In particular, the extensive cost and time requirements for handling exceptions with the currently used methods were emphasized. One expert also pointed out that even cultural aspects (e.g., German customers tend to frequently return goods) should be taken into consideration. Based on the scenarios provided by the authors as well as the scenario provided by the experts, the exception classification was confirmed. Yet two experts suggested including the criticality of the exceptions into the classification.

In the second phase, another round of semi-structured qualitative interviews was conducted with the experts of the first phase. The interviews started with a brief presentation of the proposed exception handling approach. Then, the experts were asked to apply the approach to both the scenarios given by the authors as well as their own scenarios. The experts confirmed that the classification of exceptions will simplify communicating about exceptions in an effective way, because they currently are not differentiating exception classes. Three experts noted that the BPM implementations in their respective companies are not distinguishing explicitly between the happy path and exceptions on the business level. Yet such a distinction has been made on the IT level in all three cases. Similarly, the recommended exception handling methods for each exception class are considered to be a usable assistance when choosing the best method for a given situation by all experts. However, four experts remarked that in practice, selecting an appropriate exception handling method depends on the existing legacy IT infrastructure and therefore the proposed exception handling mechanisms are more a general best practice than an individual recommendation. The proposed procedure model which defines the transitions between the exception handling approaches based on the escalation status of an exception is confirmed by all experts though all expect two experts noted that the currently used IT systems do not sufficiently support the transition between the exception handling mechanisms.

All in all, the experts recognize the added value stemming from the combination of existing approaches. They appreciate the methodical support for exception handling in BPM, as they currently have to rely on individual decisions. Yet they assume that this support should be considered as best practices that need to be carefully evaluated before being applied in real-world scenarios. Yet, three experts indicated some uncertainty that fulfilling the consistency requirements will lead to substantial and difficult to handle complexity within exception handling if the happy path is highly automated. Two experts approved the approach yet asked for a more detailed consideration of the integration in an existing IT landscape.

6. CONCLUSION

The proposed exception handling approach takes up the existing approaches described in section 3 and molds them into a single approach that is tailored specifically for handling exceptions in BPM. It promises to offer an adequate compromise between automation and flexibility, as it allows for automating both the regular process (the happy path) as well as routine exceptions, while ensuring that more complex exceptions can be handled with sufficient flexibility. By employing ACM for ad-hoc handling of exceptions, best practices may be incorporated into exception handling templates. During exception handling, these templates may be adapted to the individual objectives and requirements without the complexity that comes with AWFMS. Exception scopes ensure that defining re-entry points to the happy path is straightforward.
However, a major limitation is that the approach has not yet been tested in practice in a field trial. This could be done after an exemplary IT implementation. To achieve this, the approach has to be more specific. One open question is whether the exception handler has to return to the initial happy path in every scenario. This assumption may be too strict because in some scenarios it might be necessary to prematurely terminate the process or to execute a completely different path than predefined. The developed approach has the potential to get a grip of the growing problems in the field of BPM. In this way, the approach makes a contribution, so that exceptions in the process flow will no longer generate an organizational exception, but can be managed systematically in the future.

REFERENCES

MULTI-CRITERIA ANALYSIS AND MODELING WITH GIS FOR THE LOCATION OF LANDFILLS: A CASE STUDY IN THE SOUTHERN REGION OF SANTIAGO ISLAND, CAPE VERDE

Adilson Cabral¹ and Jorge Ferreira²
¹Faculdade de Ciências Sociais e Humanas / Universidade Nova de Lisboa
²e-Geo, Centro de Estudos de Geografia e Planeamento Regional - Faculdade de Ciências Sociais e Humanas – Universidade Nova de Lisboa
Avenida de Berna 26 C 1069-061 Lisboa

ABSTRACT

Urban Solid Waste Management (USWM) is, in terms of Geographical Information Technologies one of the most interesting and also daring fields of research. Not also because it deals with one of the major problems of development but also because it’s an environmental and social issue. It is also a very important theme when it comes to public policies and territorial planning and management. The optimal location of a landfill is obviously a very difficult decision and the consequences of a bad choice will be totally determinant to social and economic variables. Populations, their public health and environment are only the visible sides of a long list of problems with unpredictable consequences.

This study uses multi-criteria analysis in Geographic Information Systems (GIS) for the location of a landfill in the southern region of Santiago Island, Cape Verde. The methodology is based (mainly) on a raster model GIS with multi-criteria analysis and integration of the Analytical Hierarchy Process (AHP). Multi-criteria analysis assesses the suitability of the study area while the AHP ranks the problem and define the relative importance of the criteria.

To identify areas with the ability to locate the landfill, fourteen criteria were used. The possible areas were divided into Zero, Low, Medium and High capability and they resulted from the overlap of criteria based on the relative weights. In areas with high suitability, locations with values equal or above 13.9 ha were selected as optimum locations for implementing the landfill.

KEYWORDS

Landfill location, geographical information systems, multi-criteria analysis, analytical hierarchy process (AHP), Cape Verde, Santiago Island.

1. INTRODUCTION

In recent decades, the deposition of municipal solid waste in landfills has been considered a common difficulty in many regions across different countries. Due to the social and political opposition, increased population density or scarcity of available land, the complexity of its location is always a problem.

The landfill is and always will be an essential component of an integrated management system of solid waste, either as a necessary complement to other treatment processes or as a single solution treatment (Levy and Cabeças, 2006). However, the location of a landfill is a complex process to plan. The need to bring together the varying social, environmental and economic forces which requires a careful analysis of parameters (in order to mitigate environmental and socioeconomic impacts) is always a very stressful process.

The use of Geographic Information Systems (GIS) can help and assist in solving the problems of landfill location due to its capacity to integrate large volumes of spatial information coming from different sources. So, it has been used as an instrument of extreme importance to aid in decision making process by the municipal authorities (Kao and Lin 1996; Valentine, 1997; Sener, et al., 2006; Chang, et al., 2008). GIS is a toolset capable of collecting, storing, analyzing and displaying spatial data from the real world. (Burrough, 1986). The first GIS applications for the analysis of location problems appeared around the 70’s. According
to Gonçalves (2007, p.134), "the fact that these first steps have given up almost at the beginning of the use of digital mapping brought a particular interest in exploring GIS for solving location problems”.

In the literature, one can find several techniques for locating the landfill in a GIS environment. The most common approaches have been dealing with the integration of GIS analysis and multicriteria analytical hierarchy process (Siddiqui, et al. 1996; Kontos et al. 2005; Javaheri, et al. 2006; Guigiu, et al. 2009; Yahaya, et al., 2010) and the combination of GIS with fuzzy logic (Charnpratheep, et al., 1997, Al-Jarrah and Abu-Qdais, 2006; Gemiti et al., 2007). Beyond these approaches, when facing social opposition, some researchers have recently considered public participation as a vital element when deciding the location of landfills (Ishizaka and Tanaka, 2003; Fernandes, 2006; Higgs, 2006). Siddiqui, et al., (1996) were the first to combine GIS and AHP procedure to aid in site selection. The GIS was used to display and manipulate spatial data, while the AHP was used to rank potential areas for locating and evaluating the landfill weight of variables. In the same year, Kao and Lin (1996) created a GIS raster model to identify areas that better suited the location of a landfill in Taiwan. Sener et al. (2006) integrated GIS and multi-criteria decision analysis (MCDA) to solve the problem of landfill location and developed a ranking of potential landfill areas based on a variety of criteria. He also used GIS on a preliminary screening, through an individual map* classification based on selected criteria. Similarly, Chang et al. (2008) combined GIS and multi-criteria decision analysis to locate a landfill in suburban area of the City of Harlingen, Texas in the United States of America.

The methodology presented in this research was based on a raster model GIS with multi-criteria analysis and integration of the Analytical Hierarchy Process (AHP). The multi-criteria analysis was used to assess the suitability of the territory and was combined with GIS in order to analyze the data. At the end it was possible to rank several variables of the problem and define the weights of the criteria.

To identify the most capable areas to locate the landfill, fourteen criteria were used, divided into four categories: (i) land use, (ii) hydrology, (iii) morphology and, (iv) accessibility. They were selected based on international literature (Siddiqui, 1996; Kontos et al. 2005; Al-Jarrah and Abu-Qdais, 2006, Sumathi et al., 2008; Tavares, 2010; Sener, 2011, European legislation, namely the EC Directive 93, Cape Verde legislation and last but not the least, the Municipal’ Director Plans (Planos Directores Municipais - PDM), of all the municipalities included inside the area of study. The rating scale used in this study goes from 0, corresponding to null suitability, to 5, corresponding to higher suitability). The used pixel size was 35 by 35 meters.

2. THE CASE STUDY

2.1 The Study Area – Background Information

Cape Verde is an island country consisting of ten islands, nine of which are inhabited and thirteen islets. The archipelago is located between parallels 14 ° 48’e 17 ° 13 ‘north latitude and meridians 22 ° 41’ and 25 ° 22 ‘west longitude, on the West African coast, 500 km from the Cape of Senegal (Figure 1).

![Figure 1. The Southern region of the Santiago Island](image)

The case study area is located on Southern region of the Santiago Island, Cape Verde archipelago. The region has 395 km2 representing 40% of the total area. According to the last census, 153,852 inhabitants populated the island (INE, 2010). In administrative terms the region is divided into three counties (figure 1): São Domingos, Ribeira Grande de Santiago and Praia, this last one, capital city and main economic centre. The average annual temperature is 25 ° C and rainfall is scarce and distributed fairly irregular during the short
rainy season. In terms of hydrogeology, according to Gomes (2007: 194-197), "The geological formations existing in the region, form three main hydro-geological units, hydraulic characteristics and behaviours" that distinguish them:

a) **Base Unit** - the Internal Ancient Eruptive Complex, the *Flamengo* formation and *Orgãos* Formation. Characterized by a high degree of compression which gives a low permeability in what considers to the most recent geological formations. This unit has low values of transmissivity (0.2 to 5 \(10^{-5}\) m²/s);

b) **The intermediate unit** - the formations of the Eruptive Complex of the Pico de Antonia. Shows a much higher permeability to the base’ series unit.

c) **The Recent unit** - the Recent *Monte Vaca* Formation and alluvium. This unit is very permeable, making the infiltration of water toward the main aquifer. The alluvium behaves according to their grain sizes, thicknesses and percentages clays. Thus, when thick, coarse and free from clay, they have high porosity percentages and permeability and therefore allowing high productivity holes”.

### 2.2 Calculating Criteria Weights by AHP

The weighting of the criteria on the decision analysis process has major influence on the final results. For the determination of the weights, it was adopted the Analytical Hierarchy Process (AHP) proposed by Saaty (1980). This methodology divides the problem into hierarchical levels of decision making.

Following a hierarchy of problem’ variables (within each level), criteria were then compared two by two, in a decision matrix based on a quantitative scale of importance (Table 1).

**Table 1. Criteria comparison scale (Saaty, 1980)**

<table>
<thead>
<tr>
<th></th>
<th>1/9</th>
<th>1/7</th>
<th>1/5</th>
<th>1/3</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extremely</td>
<td>Very strong</td>
<td>Strong</td>
<td>Moderate</td>
<td>Equal</td>
<td>Moderate</td>
<td>Strong</td>
<td>Very strong</td>
<td>Extremely</td>
</tr>
<tr>
<td>Less important</td>
<td>More important</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The process was completed by determining the relative importance of each criteria/sub-criteria and by validating the consistency of these operations. If the consistency index was less than 10%, that meant that there is consistency or coherence in the pair wise comparison (Saaty, 1980). The value attributed to pair-to-pair comparison is based on an international literature review concerning the location of landfills, including Siddiqui, 1996; Kontos et. al, 2005; Al-Jarrah and Abu-Qdais, 2006; Sumathi, 2008; and Guiqin et. al, 2009.

Initially it was estimated the weight of the 2nd level’ criteria. At this level, hydrogeology received highest importance (40.6%), followed by accessibility (28.8%), while land use and morphology were given a relative importance of 20.8% and 9.8%, respectively (Table 2). The weighting of the 3rd and 4th level followed the same procedures previously reported.

**Table 2. Landfill siting decision criteria, weights of all criteria, ratings and references used in analyses**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Sub criteria</th>
<th>Weight</th>
<th>Distance (m)</th>
<th>Rating</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use</td>
<td>20.8</td>
<td>Built environment</td>
<td>18.5</td>
<td>&gt;2500</td>
<td>5</td>
<td>Resolução nº5/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comprehensive tourism develop. areas (ZDTI)</td>
<td>15.1</td>
<td>2500-2000</td>
<td>4</td>
<td>MAAP (2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coastal area</td>
<td>12.6</td>
<td>2000-1500</td>
<td>3</td>
<td>Decreto_Regulamentar nº 7/94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural heritage</td>
<td>18.5</td>
<td>1500-1000</td>
<td>2</td>
<td>Directiva 99/31/CE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agricultural areas</td>
<td>7.6</td>
<td>1000-500</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Airport</td>
<td>15.1</td>
<td>&lt;500</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Protected areas</td>
<td>12.6</td>
<td></td>
<td></td>
<td>&gt;7000</td>
<td>5</td>
<td>Kontos et. al, 2005; Guiqin et. al, 2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7000-6000</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6000-5000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5000-4000</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4000-3000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;3000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;800</td>
<td>5</td>
<td>Lei 44/V/2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>800-600</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

81
### 2.3 Multi-criteria Spatial Analysis in GIS using ArcGis Model Builder

According to Goncalves (2007) multi-criteria evaluation can be implemented in a GIS through one of the two following procedures: (i) The first one involves Boolean overlapping in which criteria adapts to a binary logic (0/1) in terms of suitability, sequentially combinable through logical operators like AND and OR. In this method there is no input weighting according to their relevance. Although practical, in terms of application (Boolean combinations are simple in terms of implementation), this method is not the most adequate. Variables with different relative weights deserve different treatment. The second method involves a fuzzy logic and a combination of continuous criteria. Applying a method of standardization to a continuous range (e.g. 0 to 1) and different weights, it is possible to obtain a weighted average. This method reduces the degree of subjectivity in decision making and it is very common to study patterns from multiple model variables (conversion of different measurement units to address comparisons). In general and due to its practical implementation, the Boolean overlap operations have long been used in GIS Vector data models. Fuzzy logic dominates GIS raster data model applications (Ramos, 2000).

Multi-criteria analysis is performed through three important steps: (i) a ranking of the parameters considered; (ii) a standardization of parameters’ units; and (iii) weighting where to each criterion is assigned a weight that expresses their importance relative to the other (Malczewski, 1999). Throughout this section the aim is to implement these sequences (table 2).

<table>
<thead>
<tr>
<th><strong>Accessibility</strong></th>
<th>28.8</th>
<th>Road network (main)</th>
<th>33</th>
<th>&lt;50</th>
<th>1000-50</th>
<th>1000-2000</th>
<th>2000-3000</th>
<th>3000-4000</th>
<th>&gt;4000</th>
<th>0</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Afzali et. al, 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>USWM production site</td>
<td>67</td>
<td>&lt;500</td>
<td>500-2000</td>
<td>2000-2500</td>
<td>&gt;4000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gemtzi et. al, 2009</td>
</tr>
<tr>
<td><strong>Morphology</strong></td>
<td>9.8</td>
<td>Slope</td>
<td>75</td>
<td>0-10°</td>
<td>10-15°</td>
<td>15-20°</td>
<td>&gt;20°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kontos et. al, 2005; Gemtzi et. al, 2006; Javaheri et. al, 2006; Guiqin et. al, 2009.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aspect orientation</td>
<td>25</td>
<td>NE, N</td>
<td>NW, E</td>
<td>W, SW, SE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kontos et. al, 2005; Sener et. al, 2011, INMCV</td>
<td></td>
</tr>
<tr>
<td><strong>Hydrogeology</strong></td>
<td>40.6</td>
<td>Hydrological unit</td>
<td>25</td>
<td>Unidade recente</td>
<td>Unidade intermédia</td>
<td>Unidade base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gomes (2008)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water spots</td>
<td>50</td>
<td>&gt;2500</td>
<td>2500-2000</td>
<td>2000-1500</td>
<td>1500-1000</td>
<td>1000-4000</td>
<td>&lt;400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Directiva 99/31/CE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Streams and main water network</td>
<td>25</td>
<td>&gt;100</td>
<td>100-80</td>
<td>80-60</td>
<td>60-40</td>
<td>40-20</td>
<td>&lt;20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CMSD, 2007</td>
</tr>
</tbody>
</table>
The construction of a raster model in GIS environment has allowed the extraction of preferred areas to locate a landfill in the South of the island of Santiago through the integration of multi-criteria analysis with AHP. In ArcGIS 10 with modelbuilder toolset, it was possible to develop several spatial analysis operations (figure 2) in matrix systems for modelling analysis criteria which can be summarized in: i) Neighbourhood Analysis - For modelling criteria, it was calculated the distance allowing the generation of themes (Multiple Ring Buffer) based on proximity criteria, having as inputs (information layer) the spatial attributes of sub criteria (distances); ii) Generalization - After converting the theme from vector to raster (Feature to Raster), the image was normalized by an operation of reclassification (reclassify) changing the values of image cells and resulting in a new image; iii) Derivation of curved surfaces - The altitude of the island of Santiago (1:25000) was the main theme used in this model. Using the Create TIN tool (Triangulated Irregular Network) a special tool from 3D Analyst ArcGis extension, it was possible to create a Digital Terrain Model (DTM) in which every cell contains the average altitude of the area it represents. Then, by using the TIN to Raster Conversion tool we calculate the Slope and orientation of the strands, Aspect – Slope and Aspect tools; iv) Overlay - Finally, a new theme (output) was generated from the overlay of images using the Weighted Overlay from Spatial Analyst ArcGis extension as illustrated in the analysis flowchart.

The use of ArcGis Modelbuilder tool for spatial analysis in ArcGis 10 is tremendously useful in the process of spatial analysis, since it allows the modelling of geographic information. This solution presents an obvious added value for experiencing and at the same time permits the replication of solutions based on different weights assigned and for different regions.

2.3.1 Final Aggregation of Criteria

![Figure 2. Modelbuilder diagram with layers, operations and inputs](image)

After normalization of all factors to a common scale (0 to 5) as demonstrated on table 2 and the allocation of their respective weights, we obtained four “intermediate suitability” charts for the study area (figure 3). The final suitability map resulted from the overlay of four intermediate maps by the Weighted Overlay tool based on the weights assigned to criteria (Figure 4).

![Figure 3. Intermediate suitability map](image)

![Figure 4. Final suitability map](image)

The final suitability results were then classified into four categories: Null, Low, Medium and High as illustrated in Figure 5.
3. SIZING PROCEDURE

To obtain the total area needed for the landfill, the considered data was: average per capita production of urban solid waste USW, total population, lifetime of the landfill, annual growth rate of population and specific weight of USW.

The average per capita production of USW in Cape Verde is 0.6 kg/per person/day (MAAP, 2003). For the study area and taking into account the total population (153,852 inhabitants), it is estimated that the amount of USW produced in 15 years will be 684,584 tones, assuming a population growth rate of 1.1% per year (INE, 2010) and a production per capita constant during this period (Kontos et. al, 2005; Gemitzi et. al, 2006; Guqin et. al, 2009).

The volume of solid waste in a landfill is performed by dividing the production of USW previously calculated by its specific weight (0.800 ton/m3), after compression in landfill (Levy & Cabeças, 2006; Avaliotis et al, 2004). To the result, it is added the volume of overburden necessary to place daily over the waste to cover it in the landfill. Thus, it is estimated that the total volume of solid waste (waste and overburden) accumulated during 15 years in the southern region of the island of Santiago, will be approximately 910,000 tons (more precisely 909,888.1). According to Levy et Cabeças, (2006:178) "being Vg, the overall volume and H, the reasonable height, the required area for the landfill will be": Area = Vg/H

For an excavation 8 meters tall (the value 8 meters was based on studies by Tchobanoglous et al, 1993), the minimum area of the landfill will be 113,736 m2 (about 11.4 ha.). This figure will be added over 2.5 acres corresponding to the remaining infrastructure that make up the landfill, including support facilities and curtain tree, taxiways internal systems and wastewater treatment (Levy & Cabeças, 2006).

Adding the complementary areas of the landfill, the minimum area for deployment of the landfill in the southern region of the island of Santiago will be about 13.9 acres.

Finally, in areas with high fitness (Figure 5), a selection was made, depending on the size of the necessary area calculated previously, accepting only areas not less than 13.9 acres. This selection resulted in three optimal sites for the location of the landfill. They have the minimum area established in this work that includes the landfill plus the area needed for the infrastructures that make up the landfill (figure 6).

4. DISCUSSION AND FINAL RESULTS

The suitability level of the study area resulted from the overlay of the criteria illustrated in figures 3 and their respective weights, as shown in Table 2. Figure 5 illustrates the suitability final map of the study area, based on the established pre-conditions. The pixel values vary from 0 (null suitability) to 4 (high suitability) resulting from multi-criteria and the weighted trough AHP.

The surfaces, with values between 0 and 3 were considered unsuitable for the location of the landfill. Areas with values of 0 correspond to legal restrictions established in the PDM of the several municipalities that comprise the study area, as well as legislation from Cape Verde, the European Union and also from public utility restrictions concerning the airport and steep slopes (above 20°).

The sites 1 and 2 are located in the municipality of Praia; In the northern part of the Praia city on the town of Ihéu de São Filipe and Achada Laranjo, respectively. The third site is located in the municipality of São Domingos, near the settlement of Vale Cachopo (Ribeirão Chiqueiro), as illustrated in figure 6.

Locations 1 and 2 provide better conditions for the location of the landfill, since, in addition to greater availability of the area, they are a few kilometres from the city limits of Praia (the main source of production of MSW) and close to the Circular of Praia, a ring road that connects all the three counties studied, which makes them very accessible (figure 6).
1. About the model in GIS

The combination of these two methodologies (multi-criteria analysis and analytical hierarchy process) in GIS identified three optimal locations for the landfill in the southern region of the island of Santiago.

In this research, GIS has been widely proved as a technique to support decision making regarding location of an infrastructure from the modelling of spatial data and spatial analysis to the process of planning and territorial management.

Regarding to future projects related to the identification of optimal areas for the location of landfills on the island of Santiago (or in other regions of the country), this study may serve as a solid basis, although having to be subject to regional characteristics, such as temperature, rainfall rates, depth of groundwater resources, among others. This possibility highlights the applicability and scientific usefulness of the presented model.

2. About the relevance of optimizing the location for disposal of municipal solid waste

In the future, combined with the results of multi-criteria analysis in GIS obtained in this research, it will be important to find a compromise that takes into account the sociological and political aspects, in order to prevent the effect NIMBY (Not In My Back Yard). This consensus can be achieved through awareness campaigns among the population that will be served by this infrastructure and promoting environmental education in schools (Levy & Cabeças, 2006).

From the point of view of the land management stakeholders, the location of optimal areas for the deposition of MSW is always critical. Because it's an environmental issue but also because any decision taken to optimize that location will bring implications on land value, planning of other infrastructures and on urban sprawl. An infrastructure such as that, determines all the land use in its surroundings. Considering the physiographic conditions affecting urban sprawl like steep slopes, erosion, water resources and also demographic projections (very young population and strong internal migration to cities), the location of a landfill is a decision of great importance and concern. In a context of great economic uncertainty the development of a region (located on an island) dependent on resources like tourism and landscape quality must assure that decisions are taken to minimize potential risks.

This work demonstrates the importance of GIS in land management through the use of decision support methods. Because the decision (rarely) relies on a single criterion, it was demonstrated the usefulness of using multiple variables and dimensions in order to create viable alternative choices by policymakers.

REFERENCES


MAAP (Ministério do Ambiente, Agricultura e Pescas) (Ministry of Environment, Agriculture and Fishery), (2003), Plan for solid Waste Management, Praia, Cape Verde.
INFORMATION SYSTEMS DEVELOPMENT PROJECTS
AND THE SIMPT 2.0 CASE: HOW TO TURN
AN ANTICIPATED FAILURE INTO A SUCCESS

Tommaso Federici¹, Umberto Crisalli², Danilo Scerbo³ and Alessio Maria Braccini¹

¹ Department of Economics and Business (DEIM), University of Tuscia, Viterbo, Italy
² Department of Enterprise Engineering, “Tor Vergata” University, Rome, Italy
³ Directorate-General for Development of territory, programming and international projects, Ministry of Infrastructures and Transports, Rome, Italy

ABSTRACT
This paper discusses the experience of the project for upgrading and extending a DSS of huge extent and complexity, devoted to transport management, which is still a neglected domain for IS research. This DSS belongs to an Italian Ministry and the project had the form of a public contract. For many reasons, this project was long-lasting and much troubled, and when approaching the testing phase it could have been considered failed. A case investigation through an action research reveals that drastic changes in project organization (actors composition and interaction), and in methodology (from waterfall to agile-like methods), adopted even in this late phase of the development process, contributed to turn an anticipated project failure into a success.

KEYWORDS
Project failures, Technical experts, Final users, Agile development, Transport IS, DSS development

1. INTRODUCTION

According to the estimates of the Project Management Institute, one fifth of the world gross domestic product in 2009 was realized within the context of activities organized in projects. A project is a temporary organizational effort put in place to achieve a specified goal within the boundaries of a given amount of time and financial resources (cfr. ISO/IEC 12207, 2008 p. 5). Given the relevance and the importance of projects, specific guidelines and collection of best practices were developed over time to provide guidance to organizations managing projects (Wilkin and Chenhall, 2010). Notwithstanding significant efforts in the area of project management, projects failures still occur. A project is usually considered failed if it fails to: satisfy the requirement (quality failure), respect time limit (schedule failure), or respect the financial resources limit (financial failure) (Anda, Sjøberg, & Mockus, 2009; Kappelman, McKeeman, & Zhang, 2006).

Estimating project schedules and costs in advance is anyhow recognized to be always difficult, and overpassing time and costs limits is frequent in projects. With the previous criteria almost all projects can be considered failed. More broadly then, a project is considered failed if it does not generate customer satisfaction, or value for its customer (Savolainen, Ahonen, & Richardson, 2012). Information systems development projects are not exempt to the occurrence of failures, and project in information systems have indeed a long history of failing (De Bakker, Boonstra, & Wortmann, 2010).

In the problem domain of Information Systems (IS) projects successes and failures, this paper discusses the case of the development project of a Decision Support System (DSS) for multimodal transport analysis and simulation that was originally promoted by the Italian Ministry of Transport. The paper describes the set of events occurred in the development project of such IS, and discusses the actions undertaken to turn an anticipated failure into a success. The presented case shows multiple sources of interest. At first it involves the domain of IS applied to transport management, which is still neglected in IS research. As a matter of example, a query in the AIS Electronic Library with the keywords “transport management” in titles and abstracts produces only 8 results that only marginally discuss the topic. The same query run for the MIS
Quarterly, Information Systems Research, and the European Journal of Information Systems produces no
useful results. Other elements of interest of the case are: the huge dimension of the software to be updated,
and the peculiarity of the project development that, for many causes, was reaching a failure but eventually,
during the testing phase, was re-started with a different structure and then turned into a success.

The reminder of the paper is structured as follows. In section 2 the theoretical framework of the paper is
described. Section 3 details the methodology followed in the paper and the unit of analysis. Section 4 reports
on the case experience, on the events that occurred, and on all the actions that were taken by subjects
involved in the project to turn the anticipated project failure into a success. The results of the project are
discussed in section 5. Some final remarks eventually conclude the paper in section 6.

2. RESEARCH METHODOLOGY

Under a methodological perspective, this paper follows an action research framework. According to Jönsson
(1991) and to Baskerville and Myers (2004), in action research projects researchers cooperate with domain
experts to identify solutions to practical problems, extending at the same time their scientific knowledge.
Action research is a practical oriented research methodology that perfectly suits information systems studies
in real world contexts (Avison, Baskerville & Myers, 2001).

For its characteristics action research is a good methodological framework for research projects in which:
(a) researchers are actively involved in solving practical projects activities, (b) the benefits from such actions
are expected both for the researchers and for the company or the organization running the project or the
business, (c) the knowledge obtained during the research activities can immediately be applied in practice,
and (d) the research process bounds together theory and practice (Baskerville & Wood-Harper, 1996;
Baskerville, 1999; Rapoport, 1970). Action research is best used as a methodological framework for those
research projects in which researchers actively tackle real life problems with problem solving activities. This
is exactly the case of the project investigated and discussed in this research paper where three out of the four
authors of the paper were involved in the problem solving activities in the project activities.

To report the results of the action research project in the following section, we used the groups of actors
in the development projects described by Boudreau and Robey (2005). Adapting their groups, in the
following sections actors will be therefore grouped in the following three categories: project leaders,
technology experts, and final users.

The unit of analysis of this action research study is the project for upgrading the SIMPT – Sistema
Informativo per il Monitoraggio e la Pianificazione dei Trasporti (IS for Transportation Monitoring and
Planning), in order to realize a new SIMPT 2.0. Such project was run under the form of a public contract and
lasted eight years and nine months. Because of the changes that took place during this long period (July 2003
- March 2012), mainly in the Ministry structure, and in the external context, the project involved several
people in each different role: at least 25 persons took part in a front-row activity for either the entire project
duration or a shorter period.

3. THEORETICAL FRAMEWORK

As already mentioned in the introduction, failures in project activities are not exceptional events, and
especially projects that develop IT artefacts (i.e. pieces of software or information systems) have a long
history of failures. In IT development projects specific methodologies are commonly employed to coordinate
the action of the people involved in the project, in order to ensure certainty of the outcome. These
methodologies help in controlling the evolution of software development processes, allowing project leaders
to plan the execution of the activities and to control their evolution. Such methodologies shall ensure that
project activities achieve the specified goal, in terms of requirement that have to be implemented in the final
product, in terms of costs for the development effort, and in terms of time necessary for the final product to
be delivered.

Software development methodologies

Over time different software development methodologies, with their pros and cons, were proposed and
applied in practice. The traditional organization of software development projects follows the so-called
Transportation systems are intrinsically complex as they are made up of many elements non-linearly influencing each other, and with many feedback cycles. Only some elements in the system are "technical" (vehicles, infrastructures, etc.) and governed by the laws of physics. Transportation systems functionality and their performances are usually related to transportation demand and users' behaviour. This implies that the consequences of transportation projects cannot be predicted on the basis of pure experience and intuition, but the large number of design variables and the complexity of their interactions often require models and algorithms capable of simulating the effects of several combinations of such variables to help the designer to find satisfactory combinations (Cascetta, 2009).

A decision support system (DSS) is a computer-based information system that supports decision-making. DSSs serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance. Decision support systems can be either fully computerized, pure human based, or a combination of both (Laudon and Laudon, 2002).

The theoretical foundation of a DSS for transportation consists of a set of assumptions and a limited number of functional relationships. This paradigm represents in an abstract way transportation services and their performances (supply model), travel demand and behaviour of system users (demand model) as well as their interactions (demand/supply interaction model). Apart from the internal complexity, transportation systems are closely interrelated with other systems, which represent the “rest of the world”. Transport projects may have implications for the economy, the location and intensity of the activities in a given area, the environment, the quality of life and social cohesion. For this reason, the estimation of effects and impacts is becoming increasingly important in the evaluation of transport interventions.

Moreover, the expansion of national transport policies, ranging from strategic planning of infrastructure investments to their management, with the focus primarily on efficiency, environment, security and regional equity, requires the adoption of advanced analytical tools and more sensitive to the national policy choices.

The need to make use of DSS for transport planning at the national level is common in many European
countries and it has been receiving increasing attention during recent decades (Button, 2000). For a concise state-of-the art on DSS to support national transport policies, the reader can start from Lundqvist and Mattsson (2001) which reports the national DSS developed, under-development and/or being updated for the following countries: Belgium, Denmark, Germany, Hungary, Italy, Netherlands, Norway, Sweden and the United Kingdom, among which The Netherlands and the United Kingdom have been the pioneers.

4. CASE DESCRIPTION

Since 1993 the Italian government started the development of the Italian DSS to support transportation policies called SIMPT. In the sphere of the theoretical framework of transportation DSS pictured in section 3, it is clear the importance for a country like Italy to take advantage of a tool that supports quantitatively the complex process of policy-making. The SIMPT should represent in Italy the tool to carry out the analysis of mobility at the governmental level. The evaluation process must support all the stages of the transport plan development: the preliminary analysis, the consistency checks, and the analyses of the effects of actions in relation to the objectives of efficiency, safety and sustainability. This process should be supported through the use of a diverse and scientifically based analysis tools (including quantitative methods, models and algorithms), which will ensure transparency and correctness in the development of the whole decision process. The reader should note that DSS for national transport planning is not only a government interest, but it could also be used as a specific in-depth marketing tool by national transportation companies both private and public. For example, the Italian case reports at least two transportation companies that own their specific DSS for transport planning: the DSS developed by the Italian National Roads Corporation (ANAS), and the one developed by the Italian National Railways (Crisalli, 1999). The functional architecture of a transportation DSS like SIMPT is based on:

− A database, which stores the input data (i.e. the characteristics of supply and demand) and output (as the results of the assignment and the performance indicators) relating to the transport system;
− A system of models, which represents the core component of the DSS: there are models of supply and demand that interact among each other through the simulation tool that provides functional variables which define the transportation scenario, such as, for example, the vehicle flows, the level of service attributes, the modal share, and so on.
− The user-system interaction functions (namely the graphic user interface, GUI): it is especially important since it allows the use of a complex system such as the DSS also to non-expert users. In particular it allows creating a scenario of the project, the definition and specification of transport components such as the transport demand and the service timetables, as well as the analysis of simulation results.

In the way it was designed, SIMPT allows the user to formulate intervention hypotheses on the supply configuration of the transport system and select socioeconomic and demographic scenarios in an intuitive way, freeing the user from the need to manage specific information. It is in fact the system that governs the coherence and consistency of the data, possibly making further inquiries to the user. The simulation process is mainly divided into two distinct phases: the construction of the simulation scenarios, and the activation of calculation functions. For what concern the SIMPT modelling system, there are:

− Demand models, for both passengers and freight, which allow the simulation of the main characteristics of the transportation demand;
− Supply models, for both passengers and freight, which support the representation of the main features of the infrastructure and services of the (multimodal) transport system;
− Demand-supply interaction models (also known as assignment models), that allow to estimate the use of infrastructure and services for both passenger and freight;
− Models for the analysis of impacts and performances;
− Models for the analysis of costs and revenues.

The models in SIMPT differs from other national models that can be found in the literature (Button, 2000; Lundqvist & Mattsson, 2001) for some features: the special attention on freight modelling and their integration with passenger models into a single modelling framework, the differentiation of models depending on the season (summer models and winter models), and by day of the week (models for weekdays and models for holidays), the distinction between the travel patterns of residents (nationals) with models of foreign exchange, particularly relevant given the rich tourism industry in Italy, and finally a sophisticated
treatment of the path choice for road transport, by considering separately the interregional routes from the long distance ones. By contrast, the Italian modal choice models are, however, less detailed than other national models. This aspect has been improved in the latest updates of the system.

After ten years since its first development, in 2002 the Directorate-General for the Programming (DGP) of the Italian Ministry of Infrastructure and Transports in charge of the SIMPT decided to promote a project for upgrading and extending the original system (conventionally named since then SIMPT 0). Many reasons of different nature were behind this choice: the strict exigency of updating the operating environment, particularly the hardware; the request for some new, user-friendlier, functions; the opportunity of evolving some of the embedded transport models. About the first issue, the huge machine resources required for the simulation computation had oriented the first developers in 1994 to adopt a customized server, which later became really difficult and expensive to be maintained. This also impeded any upgrading of operating systems, DBMS, and application software, because the more recent versions did not work on that machine.

The Ministry invited tenders with a public call which involved thirteen activities addressed to system upgrading, and other thirteen activities, mainly devoted to the collection of data (through surveys, interviews, and databases acquisition), essential to ground simulations on updated data. The contract was assigned to a temporary association of companies, with qualified experiences in transportation IS. At that time, the dimension of the SIMPT as a software was very great, both in terms of lines of code (more than 250,000), and of function points (about 6,300). A very rich library of documents (more than 1,200 pages) complemented the system, describing in detail all the transportation models. Technical maintenance documents (excluding the database) were missing, like for other software developed in the very years.

Because of the many organizational changes intervened in the Ministry and in the DGP, the project started one year later than expected, under a new Director and with, as final users, persons who had never used the SIMPT 0 before. The Director chose then to create a panel of scientists of transport engineers and in IS, who already knew the SIMPT and DSS in general. Their tasks were to support his decision making, but also to guide the developers by providing them technical needs and explications. Considering these difficulties and the complexity of project activities it was firstly decided to concentrate the project on data collection. During this first phase (July 2003 - June 2006) the activities concerning the upgrading and extending of SIMPT 0, planned following the traditional waterfall method, were considered as marginal. Developers concentrated on requirements analysis, particularly on the definition of the transportation models to create or adapt.

Later on, when data collection activities were almost over, but development was still at the beginning, the Ministry was split up in two different Ministries (respectively of Infrastructure and of Transport). For about one year the project did not realize substantial progresses, while expecting new responsibilities assignments. Meanwhile the panel of scientist was not renewed and the developers remained without expert interlocutors for their work. The head of the Directorate-General in charge of SIMPT changed more times in the subsequent period, with a consequent stop 'n go effect on project activities. To conclude the project, developers proceeded however with the development activities, without neither formalized requirements nor a guidance as regards technical aspects, making use of the little information already gathered, and of the knowledge gained in using the SIMPT 0. The presumed final version of the system, still to be tested, was eventually released to the customer Ministry (that in the meantime was newly re-joined) at the end of 2009.

The Ministry, following the law prescription, established a Test Committee (TC), formed by an internal manager as committee chief, and two external experts (one in transportation, and one in IS), who already were member of the former panel of scientist and soundly knew the SIMPT. The TC task was that of providing, after an adequate tests campaign, a judgement of acceptance, either positive or negative, of the system released. Just at the very initial checks the software, even though apparently complete in terms of expected functionalities, presented severe issues, both in terms of system requirements (i.e. installation did not end successfully, functions were not correctly assigned to client and server), than in functions' use (many of them returned errors or did not accomplish their aim). Because of these problems, it was not possible to proceed to more detailed tests neither to assess the quality of data produced with simulations, which in the end is the main purpose of a DSS. The problems appeared too big to be solved performing a traditional check and bug-fix phase, and the project had to be considered failed, at least as regards development activities.

When such considerations were reported to the DGP, it was decided not to close the project as failed. An exploration of any possible solution to obtain software that could correspond to the originally aims was started. This decision was made for three reasons: the long-lasting and costly litigation between the Ministry and the developers which probably would have started, the consciousness of the Ministry of the problems created to the developers, and overall the real need of the Ministry of a well performing DSS for transport
planning, in order to accomplish its institutional aims. Then, once verified the willing of the associated companies to rework this part of the project, the test phase was redrawn. Being it impossible to restart with the former waterfall method, a new method was proposed to the developers. The experts of the TC would have played the role of final users, with a specific commitment by the DGP to act on its behalf towards the developers. A closer collaboration was established by the two sides, based on periodical meeting in front of a working software release, and on a continuous bi-directional exchange of information. Even more important, it was decided to proceed by releasing subsequent small software upgrades, each one solving a coherent subset of issues. To support this plan, the test cases initially designed by the experts of the TC were detailed and adapted in order to represent what final users would have expected by the different functions and/or in diverse situations by the SIMPT 2.0.

An iterative cycle then started with subsequent steps designed as follows: the experts of TC performed a subset of tests on the current software release starting from the simpler functions; the revealed bugs and not compliances were reported in an interactive session to the developers; a new release which possibly solved the issues found was delivered by the developers; then, once verified the solution to what reported in previous tests, new tests were performed. In the first version the test cases were twenty, mainly regarding basic functions like install, log in, data access, and data change. These test cases evolved with time and grew up to fifty, later including twenty-two simulations of different transport scenarios that asked for specific testing procedures.

With regard to the contents and reliability of the SIMPT, test cases aimed at validating the correct operation of the GUI, the procedures for database management and the transport modelling system. At the first execution, and sometimes even in the following ones, some test cases succeeded, some returned a bug, others showed an interface or process designed more to a high level expert than to a Ministry's user. As regards simulations, given the complexity of the transport system described above, it is not possible to verify the output of the system in terms of analytical comparison of simulated values with target ones (as usually done for other engineering problems). Instead, the response of the modelling system has to be evaluated through the variations of the transportation variables (e.g., some characteristics of supply or demand) between the simulated and the actual scenarios. For this reason, the DSS was tested on the basis of an extensive series of tests, which have affected the response of the DSS to changes in freight transport (e.g., increasing the cost of road transport), in passenger transport (e.g., introduction of new rail high speed), as well as through the assessment of network flows carried out by the assignment of the transport demand to the national network for different simulation scenarios, including the simulation of traffic congestion.

Also considering the extent of the SIMPT and the complexity of most of its functions, to achieve bug-free software, compliant with the contract statements and, overall, with the Ministry's needs, twenty-one iterations were eventually performed. As last step, all the designed test cases were newly performed just with the intent of a test session. Finally, it is also to remark that, because the long-lasting period passed since the call for tender, no more being possible to operate on the very old versions of the operating environment there prescribed, this last phase provided as an externality the update of SIMPT 2.0 to the state-of-art of server and client operating environments.

5. DISCUSSION

The project for the upgrading and the extending of SIMPT shows a really troubled history, along which development methodology, people, responsibilities and even the same customer structure changed. To better interpret the project history, we have adapted the groups of actors in the development projects described by Boudreau and Robey (2005), because they can help to make order in the project scene, also with the aim to draw some hint out of the case. Following these authors, we have categorized the people intervening in the project into three groups: project leaders, technology experts, and final users. Members of the first group are persons that lead the project activities, usually with a strong commitment over it. Members of the second group have sound competences on technology, usually the internal or external developers' team, sometime sided by other experts. The last group gathers persons who have competences on the specific domain where the IS has to operate, and who will actually use it.

To fully accomplish its aims, a project should not only see the three groups adequately play their role, but it should also encourage a continuous and positive interaction between technological experts and final users.
The information exchange put in place between these two groups of actors generates new, essential, knowledge for both of them. Technological experts acquire, through the interaction with final users, specific knowledge on the domain, and also on users' need, way of interact with systems, expectations. On the other hand, final users become more informed on how technology works and on what it may really offer, coming also to improve and better specify their requests.

Table 1. Actors operating during the project phases.

<table>
<thead>
<tr>
<th>Project phase</th>
<th>Project Leaders</th>
<th>Technical experts</th>
<th>Final users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Requirements specification</td>
<td>Director of DGP</td>
<td>Developers team</td>
<td>Panel of scientists (only partially)</td>
</tr>
<tr>
<td>2. Design</td>
<td>Diverse managers</td>
<td>Developers team</td>
<td></td>
</tr>
<tr>
<td>3. Development</td>
<td>Diverse managers</td>
<td>Developers team</td>
<td></td>
</tr>
<tr>
<td>4. Testing (beginning)</td>
<td>TC chief</td>
<td>Developers team</td>
<td></td>
</tr>
<tr>
<td>5. Testing (iterative cycle)</td>
<td>TC chief</td>
<td>Developers team</td>
<td>TC experts</td>
</tr>
</tbody>
</table>

Table 1 shows the actors that played the relevant role along the project phases. As it can be noticed, a real, collaborative, fully informational exchange between the technological experts (in this case the members of the developers team provided by the associated companies) and the final users started only in the last phase of the project, when it was decided to redesign the project organization. Actually, in the previous phases the development project missed final users' component, because in the DGP there was no employee who already knew the SIMPT, while the scientists of the panel were not designed to play such role, and had however few occasions to do it. Despite the high level of transport IS competences of the developers, their lack of knowledge on the SIMPT, mixed with the absence of interaction with informed users, drove to a system that resulted both unusable and different from consumer's expectations. The situation dramatically changed when it was decided that the TC experts, who already deeply knew the SIMPT, would have had to play the final users' role, by transferring information to the developers and guiding them ("this interface is designed to be used by a research centre engineer, not by a Ministry employee").

Another important element to be highlighted, in order to identify what helped to turn the project destiny, is the decided change of the development methodology. The waterfall method, initially adopted like in other public projects, could not be replicated after six years. Moreover, two other conditions supported the choice to adopt a different method: the availability of a certain final date, necessary when signing a public contract, was any longer as much important, and more significant, even though not compliant and with many bugs, the released system could be used as a prototype to be assessed and improved.

Although never named in this way by the project members, the methodology adopted in the final phase presents several elements that recall the agile methodology (Pikkarainen et al., 2005). First of all, the already mentioned start of a continuous, open collaboration between customers (in this case, the two TC experts on behalf of DGP) and developers. Second, the use of the released system as software to work on to provide requests of changes and improvements. Third, the adoption of iterations, each one involving a small subset of functions to be changed, fixed or realized, and then a small planning for each iteration. Fourth, the recourse to face-to-face sessions with TC experts and developers in front of a same computer running the new SIMPT, in order to assess the new release, and in the last period also to activate the pair programming technique. Fifth, because of the circumstances, the forcedly adoption of test-driven development, which more focuses the development on what the user really wants. All this points seem to be as many drivers for the project recovery. They also seem to testify the successful use of the agile methodology even in a complex project, which laid in a problematic situation. As regards the high number of performed iterations, it does not have to astonish, when considering the extent and the complexity of the system in question.

6. CONCLUSION

This paper investigates, through an action research, the project for upgrading and extending the SIMPT, a large and complex DSS devoted to transport monitoring and simulations. As the system belongs to an Italian Ministry, the project had the form of a public contract. Even if this case is peculiar for its characteristics, it
can provide very useful generalizable hints. For several reasons this project has been long lasting and much troubled, and when approaching the testing phase it could have been considered as failed. Some changes in the project organization and in the methodology put in place even in this late phase of the development process contributed to turn a nearly failure into a success. From the discussion of the case, reinforcing final users’ roles, and adopting methods similar to those of agile development, appear to have been the most effective measures to turn the failure into a success.

REFERENCES


CHIEF INFORMATION OFFICERS’ PERCEPTIONS OF IT PROJECTS SUCCESS FACTORS IN SAUDI ARABIAN PUBLIC ORGANIZATIONS: AN EXPLORATORY STUDY

Abdulaziz I. AlMajed and Pam Mayhew

School of Computing Sciences, University of East Anglia - Norwich NR4 7TJ, UK

ABSTRACT
Despite of the huge investments in information technology (IT), IT project success rates are unsatisfactory, and still remain very low. This issue has been investigated by many researchers all over the world to identify the critical success factors. However, there is no universal agreement on which factors are significant to success. This paper presents an exploratory study of the main factors that affect IT projects success in Saudi Arabian public organizations from chief information officers’ (CIOs) perceptive. A qualitative approach using semi-structured interview method was used to collect and analyze the data. Interviews were conducted with CIOs to gather their opinions about the IT projects success factors. The findings of the study proposed seventeen factors that may have effect on IT projects success. Conflict of interest, knowledge management, rewards and recognition, top management stability and project management office (PMO) have been collected from the interviewees. Top management support and commitment, strategic planning, project management, process management, project team competency, IT infrastructure, change management, risk management, communication management, training and education, supplier management, stakeholder management have been collected from the literature and confirmed by the interviewees.

KEYWORDS
IT project; CSF; CIO; Public; Saudi

1. INTRODUCTION
Information technology (IT) has become a crucial part of any organization to run effectively and efficiently. In fact, IT has been considered to be the fastest growing industry in developed countries (Hartman and Ashrafi, 2002). The culture and structure of any organization have been impacted by the implementation of IT projects (Doherty, 2003). Therefore, organizations have invested a lot in IT projects as a result of its increasing role. It has been estimated that large organizations are spending up to 50% of their total capital expenditure on IT (Renemka, 2000).

However, many studies have found that IT project failures are very common, and the rates stay high in spite of the vast investments in IT. Standish chaos summary report provides a view of project statistics mainly in developed countries (US and Europe). This report found that 32% were considered successful and 24% were considered total failures and abandoned. The remaining 44% were considered partially fail or challenged (Standish-Group, 2009). Table 1 tracks the progress of Standish Group for project status (1994-2008).

Table 1. Project resolution results from CHAOS research for the years 1994–2008

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Succeeded</td>
<td>16%</td>
<td>27%</td>
<td>26%</td>
<td>28%</td>
<td>34%</td>
<td>29%</td>
<td>35%</td>
<td>32%</td>
</tr>
<tr>
<td>Failed</td>
<td>31%</td>
<td>40%</td>
<td>28%</td>
<td>23%</td>
<td>15%</td>
<td>18%</td>
<td>19%</td>
<td>24%</td>
</tr>
<tr>
<td>Challenged</td>
<td>53%</td>
<td>33%</td>
<td>46%</td>
<td>49%</td>
<td>51%</td>
<td>53%</td>
<td>46%</td>
<td>44%</td>
</tr>
</tbody>
</table>
Unfortunately in high income developing countries such as Saudi Arabia, there are no statistics reports about the IT projects success or failure rates. However, there is only one study has been done by Alfaadel et al. (2012) that showed the failure rate of IT project is approximately 52%. In reality, IT project failures financial impact is huge. About 150 billion US dollars are misused every year on IT projects failures in US and a comparable amount is stated in the European Union (Gauld, 2007). American Airlines Corporation AMR Information Services (AMRIS), and London Ambulance System are examples of high profile IT project failures reported in the literature (Sauer, 1993; Beynon-Davies, 1995).

Even though there is an intensifying theoretical and empirical studies on IT project failures, most of these studies are derived from the private sector. In fact, the failure rate of IT projects is worse in the public sector reaching around 84% (Gauld, 2007). Therefore, the aim of this research is to identify the factors that may affect the success of IT project in Saudi Arabian public organizations from CIO’s perspective. The paper is organized as follow: section 2 presents a literature review, and section 3 describes the research methodology. Section 4 presents data analysis and findings, and the last section provides the conclusion and further research.

2. LITERATURE REVIEW

Several research studies have been done in the area of project management to identify the critical success factors (CSFs) that effect the success and/or failure of projects over the years (Belassi and Tukel, 1996; White and Fortune, 2002; Pinto, 1986). For example, Pintos (1986) identified ten CSFs such as project mission, top management support, and client consultation. However, these studies are not focused on IT industry projects only. In fact, IT projects are different from other types of projects because they have distinctive characteristics such as high complexity and high chances of project failure (Rodriguez-Repiso et al., 2007). It has been agreed amongst some researchers that different industry types have differences in project management (Cooke-Davies and Arzymanow, 2003; Zwikael and Globerson, 2006). Moreover, there is no project success factors would be applicable to all projects (Dvir et al., 1998). In reality, for a specific IT project such as the Enterprise Resource Planning (ERP) and Health Information System (HIS), there is no general agreement on which set of factors are the key to success.

Most of the CSFs studies concentrate on specific IT projects such as ERP. Nah et al. (Nah et al., 2003) conducted a survey of CIOs from fortune 1000 companies on their perceptions of the CSFs in ERP implementation and found that top management support, project champion, ERP teamwork and composition, project management, and change management program and culture were the most five critical factors that identified by the CIOs. Similarly, Umble et al. (2003) identifies in their case study of a successful ERP implementation that software selection steps and implementation procedures as critical success factors. In review of different resources such as journals and conference proceedings across ten different countries, Ngai et al. (2008) identified eighteen CSFs for the successful implementation of ERP and found that “top management support” and “training and education” were the most frequently cited CSFs.

With respect to the situation in Saudi Arabia, Alfaadel et al. (2012) study was the first to discuss the IT project success and failure in general in Saudi Arabia. They found in their study that the most important success factors are clear statement of requirements, top management support, and proper project planning. However, few studies have been done in ERP, Portal and Health Information System (HIS) (Al-Turki, 2011; Al-Mudimigh et al., 2011; Abouzahra, 2011).

3. RESEARCH METHODOLOGY

This study empirically investigates the factors that play a significant role in the success of IT project in Saudi Arabian public organizations. In order to identify these factors, a qualitative method using semi-structured interview is used. Qualitative approach assists the researchers to reach deeper into the participants’ experiences. This exploratory study carried out through interviewing a number of CIOs (10) using a list of factors which has been collected from the literature review.

The semi-structure interview process went through the following steps. First, the researchers proposed a list of factors from a thorough review of the literature on the success factors of IT projects to be examined
and modified by the interviewees. For the interview to succeed and to save the CIO’s valuable time, the researchers had emailed this list to them in advance in order to enable full discussion of the topics included. Only those who had at least five years’ experience of IT management were chosen. The reason for that was to consult people with significant levels of practical experience.

Invitations were sent to 20 CIOs in the field, and only 10 agreed to participate in this study. The researchers conducted interviews during October 2012. Each interviewee was briefed on the information concerning the aims of the study and the purpose of the interviews. The duration of each interview was one hour, and each interview was conducted on a one-to-one basis. The interviews were conducted in English. Participating CIOs were assured of their anonymity before the beginning of each interview. The researchers conducted the interviews using the voice over IP such as Skype. None of the interviews were tape-recorded because the CIOs requested that information they provided not be recorded. Therefore, notes were taken. These interview notes were emailed to each CIO after the interview for confirmation and validation.

After the interview process with the CIOs had finished, the researchers started to analyze the interviewees’ answers. The researchers transcribed the results in a separate form for each interviewee. This form consists of the following: CIO’s background, organizational and IT characteristics, a list of factors from the literature to be confirmed if it is important or not, and a space for any additional factors that can be added. In the data transcribing process, the researchers marked (✓) when the CIO confirmed the importance of one of the factors that were listed in the interview results form. If, however, the interviewee suggested a new factor, the researchers added it to the proper space in that form. The researchers also wrote down the interviewees’ comments about each factor. After this, the process of transcribing the interview results was finished, and the data analysis process started in order to identify the factors which have influence on IT project success.

4. DATA ANALYSIS AND FINDINGS

For each CIO (CIO#X), the following information has been considered: CIO background (Age, Education Level, and Experience), and the important factors. The factors that the CIO had confirmed or rephrased are called “Factors From Literature”, and the factors that he/she had added are called “Factors Added by CIO”. In order to place this information in one table, all the factors (both Literature (L) and Added (A)) have been coded in another table which called “Factors’ Reference Table” (see table 2). The breakdown of the CIOs interviewed has been summarized in Table 3.

Table 2. Factors’ reference

<table>
<thead>
<tr>
<th>Factors From Literature (L)</th>
<th>Factor Code</th>
<th>Factors Added by CIO (A)</th>
<th>Factor Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Management Support and Commitment</td>
<td>L1</td>
<td>Conflict of Interest</td>
<td>A1</td>
</tr>
<tr>
<td>Strategic Planning</td>
<td>L2</td>
<td>Knowledge Management</td>
<td>A2</td>
</tr>
<tr>
<td>Project Management</td>
<td>L3</td>
<td>Rewards and Recognition</td>
<td>A3</td>
</tr>
<tr>
<td>Process Management</td>
<td>L4</td>
<td>Top Management Stability</td>
<td>A4</td>
</tr>
<tr>
<td>Project Team Competency</td>
<td>L5</td>
<td>Project Management Office</td>
<td>A5</td>
</tr>
<tr>
<td>IT Infrastructure</td>
<td>L6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td>L7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk Management</td>
<td>L8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication Management</td>
<td>L9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training and Education</td>
<td>L10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier Management</td>
<td>L11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stakeholder Management</td>
<td>L12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Breakdown interviewed of CIOs

<table>
<thead>
<tr>
<th>CIO No.</th>
<th>Age</th>
<th>Educational Level</th>
<th>Experience</th>
<th>Factors From Literature (L)</th>
<th>Factors Added by CIO (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIO#1</td>
<td>&gt;40</td>
<td>PhD</td>
<td>16-20</td>
<td>L1,L2,L3,L4,L5,L6,L10,L11,L12</td>
<td>A1,A2</td>
</tr>
<tr>
<td>CIO#2</td>
<td>26-30</td>
<td>Bachelor</td>
<td>6-10</td>
<td>L1,L2,L4,L5,L6,L7,L8,L9,L11,L12</td>
<td>A3</td>
</tr>
<tr>
<td>CIO#3</td>
<td>31-35</td>
<td>Master</td>
<td>6-10</td>
<td>L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A4</td>
</tr>
<tr>
<td>CIO#4</td>
<td>31-35</td>
<td>Master</td>
<td>6-10</td>
<td>L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A5</td>
</tr>
<tr>
<td>CIO#5</td>
<td>&gt;40</td>
<td>Master</td>
<td>16-20</td>
<td>L1,L2,L3,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A1,A2</td>
</tr>
<tr>
<td>CIO#6</td>
<td>31-35</td>
<td>Master</td>
<td>11-15</td>
<td>L1,L2,L3,L4,L5,L6,L9,L10,L11,L12</td>
<td>A5</td>
</tr>
<tr>
<td>CIO#7</td>
<td>31-35</td>
<td>Master</td>
<td>6-10</td>
<td>L1,L2,L3,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A5</td>
</tr>
<tr>
<td>CIO#8</td>
<td>&gt;40</td>
<td>PhD</td>
<td>&gt;20</td>
<td>L1,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A5</td>
</tr>
<tr>
<td>CIO#9</td>
<td>26-30</td>
<td>Bachelor</td>
<td>6-10</td>
<td>L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A5</td>
</tr>
<tr>
<td>CIO#10</td>
<td>36-40</td>
<td>Bachelor</td>
<td>11-15</td>
<td>L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12</td>
<td>A5</td>
</tr>
</tbody>
</table>

4.1 Factors Affecting IT Projects Success (Literature Review List)

The results of IT CIO’s success factors of IT projects are mostly consistent with literature review. The following subsections provide a description of the research outcomes. For each factor, it starts with a brief definition and CIOs’ comments for the researchers’ question “To what extent factor X is important to IT projects success?”.

4.1.1 Top Management Support and Commitment

Top managers should dedicate time to review plans, follow up on results and facilitate management problems. 100% of CIOs agreed that this factor is critical. CIO#2 confirmed that by saying “definitely, without endorsement/sponsorship of top management, the project is likely to be hindered”. CIO#4 commented “it is very critical to ensure gaining their continuance support to resolve any obstacles may face project progress”. CIO#8 mentioned “it is very important factor throughout the project lifecycle. Various types of support from the top management such as budget allocation, encourage managers to cooperate, facilitate the organization environment for IT project adoption, speed up approvals, ease cooperation and support of stakeholders, partners, and the board of directors, prepare organization for change brought by the new IT project”. CIO#10 said “without the management support, the projects tend to fail. We have seen many projects that were started and the management wishes but not supporting, and it turned to fail.”

4.1.2 Strategic Planning

IT Strategic planning should be aligned and integrated with the organization’s strategy. 90% of CIOs agreed that this factor is critical. CIO#2 commented “strategic planning is without a doubt a considerable success factor. Even if the project is implemented fully, with the absence of vision and direction that key drivers to any project, we will be missing the main value out of it. Typical examples in our environment, I’ve seen live cases of IT projects where two departments have implemented the same project fully twice causing double amount of finances, efforts of man hours, and double the amount of hardware/software assets causing administration overhead”. CIO#3 said “It’s imperative to have a very precise and clear strategic plan to govern the mission of the organization and drive it smoothly to its objectives with well designed, implemented, and controlled strategic plan.” CIO#4 mentioned “IT projects must be aligned with organization strategic planning and organization objectives.” CIO#7 said “IT strategy acts as an enabler to business strategy. Projects should be planned strategically to achieve business goals”.

4.1.3 Project Management

Project management is term as an application of knowledge, skills, tools and techniques to project activities to meet project requirements (PMI, 2004). 80% of CIOs agreed that this factor is critical. CIO#3 confirmed the importance of project management by saying “Projects nature are getting more complicated and intersected nowadays especially in Saudi Arabia, thus without proper project management, project managers and decisions makers want be able to properly control and prioritize them along with losing accurate and
right projects status”. CIO#4 said “to ensure appropriate management during project life cycle to deliver project objectives”. CIO#7 commented “IT projects are usually associated with costs and resources which need to be managed. Because of these characteristics of IT projects, project management is crucial”. However, CIO#2 said “I don’t see personally that with the absence of project management methodology that the project would be compromised, because some project managers intuitively can manage the full details of the project and assure it can be matching the expectations based on their practical experience and knowing how to make it a success.”

4.1.4 Process Management

Process management is a set of methodological and behavioral practices which are implemented to manage and improve processes that produce products and services. 60% of CIOs agreed that this factor is important. CIO#2 said “It’s important to synergize and harmonize the project internal processes with the operational organization. It would impact the transition for example of the project if we don’t have such process established and well defined and informed to every party”.

4.1.5 Project Team Competency

Project team refers to the project manager and all the project team members, and this team should recruit the best individuals in the organization. 100% of CIOs agreed that this factor is critical. CIO#3 confirmed that by saying “the team is the arms and tools for project managers, their valuable contributions are the fuel that accelerates the project execution. Failing to select the right resources along with poor training makes project manager life harder and put the project success on the edge”. CIO#4 commented “sufficient project team size, qualifications and experiences to ensure well-organized project tasks accomplishments & delivery as planned. Existence of good project manager will motivate project team and overcome any obstacles may affect project progress”. CIO#10 said “serious and committed team members will ensure the activities are delivered on timely manner”.

4.1.6 IT Infrastructure

IT infrastructure is a comprehensive term that includes equipment, networks, and applications. 100% of CIOs agreed that this factor is critical. CIO#1 confirmed that by saying “IT infrastructure is crucial for any IT project”. CIO#3 mentioned “IT infrastructure is the backbone of any implemented information system”. CIO#5 said “I cannot imagine having a system without having a proper IT infrastructure”.

4.1.7 Change Management

Change management is the application of the set of tools, processes, skills and principles for managing the people side of change to achieve the required outcomes the project. 80% of CIOs agreed that this factor is critical. CIO#2 confirmed that by saying “There is always resistance of a change, and change management stream would be needed to ensure change can happen”. CIO#4 commented “it needs to be controlled in integrated & effective way since it has direct impact on organization”. CIO#10 said “IT projects tend to fail because of changes and managing the changes. We have seen many projects dragged for long time and time & money consumed just because of wishes and changes required”.

4.1.8 Risk Management

Risk management is the identification, analysis, assessment, control, and avoidance, minimization, or elimination of unacceptable risks in the project. 80% of CIOs agreed that this factor is critical. CIO#2 confirmed that by saying “Risk planning, register and mitigation plan are all indicators of success of the project”. CIO#3 commented “Risks are always there, having proper risk management plan tailored for every project would definitely reduce the risk factors and increase probability of having a very successful project”. CIO#4 said “Early establishment of clear risk plan and risk response mitigate projects failure”.

4.1.9 Communication Management

Communication management is the systematic planning, implementing, monitoring, and revision of all the channels of communication within all the people involved in the project. 80% of CIOs agreed that this factor is critical. CIO#2 confirmed that by saying “it is critical for all project staff and stakeholders. It’s important to run communication mechanisms whether video broadcasts over local portal, communication messages,
online training sessions, surveys, etc... It’s a mean of bringing the value of the project in front of everyone touched by it”. CIO#3 commented “Different project members and stockholders require a very clear communication plan to avoid any missing information and keeping the project under control. It is strongly recommended to keeping project members based on their authorities and roles up to date with project status and information via proper communication channels”. CIO#10 said “Communication in Saudi Arabia is the weakest part, even we tend to like to chat and talk, when it comes to communicating all the project and project status, we found that most of projects failed to manage that part successfully”.

4.1.10 Training and Education

Training and education is the acquisition of knowledge, skills, and competencies, and this facility should be available to all concerned people including project team members and end users. 90% of CIOs agreed that this factor is critical. CIO#3 confirmed that by saying “It’s imperative for the success of the project during the project life cycle and last but not least during the project post implementation to ensure smooth operation”. CIO#7 said “Contentious professional development for IT staff is really important to keep them aware about updates in the field. Also, training for both end-users and IT staff aids them to utilize information system efficiently. Also, it will help to eliminate their resistance and it will increase their readiness to change”.

4.1.11 Supplier Management

Supplier management is a business process that allows a company to adequately select its vendors and negotiate the best prices for goods and services that it purchases. 60% of CIOs agreed that this factor is important. CIO#2 confirmed the importance of supplier management by saying “it plays a critical role in the project success. We need to be cautious about setting a clear process of supplier selection to assure that the choice is totally un-biased to a preferred vendor which may affect the project outcome”.

4.1.12 Stakeholder Management

Stakeholder management is the process of managing the expectation of anyone (person or organization) that has an interest in a project or will be effected by its deliverables or outputs. 70% of CIOs agreed that this factor is important. CIO#4 confirmed that by saying “Stakeholders of a project are your key people that will drive the PMO to meet their expectations and be in close contact during the project cycle since they carry big influence on how to translate the project outcomes and capture the value added to the line of business”. CIO#3 mentioned “stakeholders with their different roles, high expectation, and influences on the project which should be watched and mentor closely and sharply”. CIO#9 said “An unhappy one of the stakeholders can close the project”. CIO#10 commented “It’s always important to bring the stakeholders in the same picture”.

4.2 Factors Affecting IT Projects Success (CIOs’ List)

4.2.1 Conflict of Interest

A conflict of interest is a set of circumstances that creates a risk that professional judgment or actions regarding a primary interest will be unduly influenced by a secondary interest. This factor has been added by CIO#1 and his comment is: “This factor is critical because it might hinder the success of the project. Conflict of interest can be in different levels and shapes. There are many examples of that such as recruit unworthy personnel for the project, awarding the project to a company which is ineligible, etc.”

4.2.2 Knowledge Management

Knowledge management is the process through which organizations generate value from their experiences, intellectual and knowledge-based assets in terms of resources, documents, and people skills. This factor also has been added by CIO#1 and his comment is: “It is very important issue from two points of view: to learn from the past experience of unsuccessful projects in order to avoid the reasons behind the failure in the future and to have the knowledge transferred after the completion of success projects”.

100
4.2.3 Rewards and Recognition

Rewards and recognition defines the incentives, rewards, and recognition plan in its entirety, and it should be available to all employees in the organization. This factor has been added by CIO#2 and his comment is: “Although this is not fully enabled in our organization, but I see great importance of increasing people moral and spirit by standardizing a rewarding process and be always recognizing people efforts and accomplishments”.

4.2.4 Top Management Stability

Top management stability refers to the impact of the top management unpredictable change or turnover. This factor has been added by CIO#3 and his comment is: “In our organization, the general director has been changed three times in less than four years which was very critical to the strategic planning of our IT projects. Every one of them had his own vision about the critical IT projects so he made many changes which caused wasting a lot of resources and delay clients’ projects”.

4.2.5 Project Management Office

A Project Management Office (PMO) is a group or department within an enterprise that defines and maintains standards for project management within the organization. This factor has been added by CIO#5 and his comment is: “It is a crucial to plan, prioritize, monitor, measure and report to the entire project stakeholder about the status of each project. It manages all the resources across many projects implementing simultaneously”.

5. CONCLUSION AND FURTHER RESEARCH

This paper has presented an exploratory study of CIOs’ perceptions of IT projects success factors in Saudi Arabian public organizations. The findings of the study proposed seventeen factors that may have impact on IT projects success. These are: top management support and commitment, strategic planning, project management, process management, project team competency, IT infrastructure, change management, risk management, communication management, training and education, supplier management, stakeholder management, conflict of interest, knowledge management, rewards and recognition, top management stability and PMO. The last five factors have been added by the CIOs.

The anticipated contribution to the academic community includes development of an understanding of the organizational factors that affect IT projects success. This study contributed to existing knowledge in different ways. First, it managed to identify a number of factors which are critical to the success of IT projects in high income developing countries in general and in Saudi Arabia in particular. Second, this study succeeded in synthesizing existing literature in this area with its findings from real world experience. The success factors of IT projects found by this research are also expected to be applicable to other high income developing countries. Further research can be done to validate the new list which has been added by the CIOs, and find the interrelationships between those factors and their impact on IT project success.

REFERENCES


HIGHWAY INCIDENT DETECTION BASED ON PROBE CAR DATA

Hiroto Akatsuka¹, Atsuhiro Takasu², Kenro Aihara² and Jun Adachi²
¹The Graduate School of Information Science and Technology, The University of Tokyo - 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo, 101-8430 Japan
²National Institute of Informatics - 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo, 101-8430 Japan

ABSTRACT

In this paper, we propose a method for automatic incident detection (AID) based on probe car data (PCD). Traffic incidents cause serious traffic congestion, which eventually leads to economic loss and environmental pollution. The early detection of a traffic incident is a very important component of traffic management. Many traffic incidents also occur during disasters, so the early detection of incidents is very important for disaster mitigation and damage limitation. From this perspective, PCD may be regarded as a cost-effective data source. A feature that can be obtained from PCD is different from that of road installation-type sensors. Thus, we investigated a feature that can be obtained from PCD to exploit PCD to the utmost. This feature is an index that represents the speed “deviation”, which is extracted from each car’s temporal and spatial mean speed and used for AID. We applied our method to data collected on days when incidents occurred. The evaluation results showed that our proposed method detected each incident correctly with an average false alarm rate of 0.08% or less. This shows that the method could be practiced effectively.

KEYWORDS

Automatic Incident Detection, Probe Car Data, Big Data.

1. INTRODUCTION

The advance of motorization means that cars are widely distributed throughout society and they are indispensable as a means of transportation for people and objects. However, road traffic has increased greatly and this has led to the problem of traffic congestion. The Japanese Ministry of Land, Infrastructure, Transport, and Tourism estimated that over 3,810 million man-hours are lost each year because of traffic congestion, which equates to over 30 hours per person. In monetary terms, this approximates to 12 trillion yen, which is equivalent to 2% or more of the GDP [2]. Traffic congestion also causes other problems such as fuel wastage and environmental pollution. Therefore, traffic congestion relief is of major importance.

There are two types of traffic congestion: natural traffic congestion and traffic congestion caused by traffic incidents (abnormal traffic congestion). Natural traffic congestion will occur when the number of cars exceeds the capacity of a road, and natural traffic congestion is decreasing gradually due to road maintenance and improvements. By contrast, abnormal traffic congestion is caused by traffic incidents. Traffic incidents are events that cause a disturbance in the normal traffic flow such as a disabled car, traffic accident, and other events. If a traffic incident lasts for more than 1 minute, it will cause traffic congestion for about 5 minutes, although the congestion will last longer during rush hour and the associated losses will also be greater. Many traffic incidents may occur during disasters, such as road cutoffs and damaged cars, which can disrupt emergency responses and repair work. Therefore, it is very important to detect incidents as soon as possible.

In this context, many studies have investigated automatic incident detection (AID) algorithms [3, 11]. Detecting traffic incidents rapidly, accurately, and automatically can facilitate traffic management and reduce the losses due to traffic incidents. Most conventional AID algorithms use data related to the traffic flow and concentration, which are obtained using road installation-type sensors such as loop detectors and fixed-point video cameras. However, the installation and maintenance of these sensors are expensive and labor intensive, and data can only be obtained from roads where sensors are installed.
By contrast, systems that closely combine the real world and IT have emerged in recent years. The availability of inexpensive sensors, such as the GPS sensors and three-axis accelerometers found in personal smartphones, means that real-world phenomena can be readily observed as digital data using various sensors. These sensors are incorporated within various objects that have permeated society, so these data are very large in scale and scope.

Probe car data (PCD) is one form of such data. Probe cars use GPS receivers and GSM/GPRS transmitters to periodically transmit their location, speed, and other data to a central control system. Each probe car acts as a moving sensor in the traffic stream and does not require the installation of a fixed-point sensor in advance. Therefore, PCD is large-scale and cost-effective data source. Various approaches have been proposed for the deployment of PCD such as traffic estimation and prediction [4], traffic congestion identification [5, 9], and route recommendation [7].

In this paper, we propose an AID method based on PCD. The focus was a highway in this research. During anomaly detection, certain features are extracted from data before determining whether they are normal or abnormal. Therefore, the type of feature extracted and the methods used to determine whether it is normal or abnormal are very important. We investigated a feature that could be derived from the PCD and used it for anomaly detection during AID. We evaluated our method by applying it to real data. The results showed that our method correctly detected incidents with an average false alarm rate (FAR) of 0.08% or less.

The major contributions of this work are as follows.
- We propose a new feature, i.e., an index that represents the speed “deviation”, which indicates the traffic conditions on a road section. This feature can be obtained using only one car because it is less vulnerable to individual differences compared with the traveling time or speed.
- We analyzed the situation during traffic incidents and identified a feature vector that captured the situation effectively.
- Each road section has different characteristics, so the thresholds used for incident detection need to be determined automatically based on previous data for each road section. We propose a simple method for determining the thresholds automatically.

2. RELATED WORK

Some algorithms are proposed although there are not many studies of AID based on PCD. Cheu et al. proposed an algorithm that detected incidents by comparing the current traveling time with the average travel time during corresponding day and time periods [6]. This method was based on the premise that the traveling time will become longer than usual when a traffic incident occurs. However, longer traveling times occur during incidents and natural congestion, so this method may be unable to distinguish incidents from other forms of congestion that can increase the traveling time. Li and McDonald used the traveling time and traveling time difference to detect rapid changes in the traveling time due to traffic incidents [12]. Zhu et al. selected feature vectors based on the spatial and temporal characteristics of incidents [10]. They used a multilevel detection method that involved filtering, outlier detection, and delay monitoring.

However, most of these earlier approaches used the traveling time or speed as features for detection of incidents. The reliability of their estimates is highly dependent on the number of cars on the road because of individual differences and it is difficult to distinguish abnormal traffic congestion from natural traffic congestion by traveling time or speed feature. This paper proposes a new PCD feature that is suitable for traffic incident detection even with less probe cars.

3. FEATURE EXTRACTION

PCD is large-scale and cost-effective data source. Thus, the method that exploits the PCD to the utmost is needed. A feature that can be obtained from PCD is different from that of road installation-type sensors. Therefore, a new viewpoint is required that is different from the conventional AID approach. During conventional AID based on fixed-point sensor data, traffic incidents are detected using features that reflect the overall situation such as the traffic flow and traffic concentration on a target road. By contrast, traffic incidents are detected using a feature obtained from each car during AID based on PCD. If we can extract the
necessary information for AID using only one or a limited number of cars on the target road to detect traffic incidents, we could exploit PCD to the utmost. Thus, it may be more effective to exploit a feature that is not affected directly by individual differences, unlike the speed and traveling time. Therefore, we propose a feature based on the spatiotemporal traffic status [8]. We describe this concept before explaining the feature we propose.

3.1 Spatiotemporal Traffic Status

In a spatiotemporal traffic status plot, a point has two values that comprise its coordinates: a temporal mean speed (TMS) and a spatial mean speed (SMS) [8]. The TMS is the average speed over time and it contains temporal information.

**Definition 1. Temporal mean speed:** If a car passes through a road section with length \( L \) in the traveling time \( T \), the TMS of the car is defined as follow.

\[
TMS = \frac{L}{T}
\]  

(1)

By contrast, the SMS is the average speed at different locations and it contains spatial information.

**Definition 2. Spatial mean speed:** Divide the road section with length \( L \) into \( N \) small segments with length \( L/N \). If \( t_i \) is the time when a car passes through the \( i \)th small segment, the SMS is defined as follows.

\[
SMS = \frac{\sum_{i=1}^{N} \left( L/N \right)}{N} t_i
\]  

(2)

For example, suppose that a car passed through a road section with length 6[km] in 6 minutes. However, the car stopped for 3 minutes at a certain point on the road while it operated at a fixed speed outside this period. The TMS of the car was \( 6/[km] / 0.1/[h] = 60/[km/h] \). Suppose that the number of small segments \( N = 120 \). The car operated at \( 0.05/[km] / (0.05/[h] + 0.0004/[h]) \approx 1/[km/h] \) during the segment that included the stoppage, whereas it operated at \( 6/[km] / 0.05/[h] = 120/[km/h] \) outside that segment, so the SMS of the car was \( (120/[km/h] * 119[seg] + 1/[km] * 1[seg]) / 120[seg] \approx 119/[km/h] \).

Thus, the speed of the car dropped rapidly with longer stoppage times and smaller segment lengths, so the SMS became larger compared with the TMS. Yoon et al. used this feature to estimate the traffic status of urban streets which contain many traffic interruptions such as traffic lights, stop signs, and similar traffic obstacles. After taking into consideration of the TMS and SMS, these interruptions are discounted as traffic congestion if a car stops during a traffic interruption and the TMS increases. However, the TMS and SMS features cannot be used directly for AID. Figure 1 shows the TMS and SMS plots for cars that passed through a specific section of the Metropolitan Expressway 3 Shibuya-sen (ME3) on August 12, 2011. Each point in Figure 1 corresponds to one car. A traffic accident occurred in this section on that day. One lane was closed to traffic by this accident and this led to traffic congestion. However, traffic congestion occurs frequently on roads in urban areas, so many points are plotted near the origin. Thus, the traffic congestion caused by a traffic incident is indistinguishable from natural traffic congestion based on the speed values alone.

3.2 Speed Deviation

To overcome this problem, we propose a new feature extracted from the TMS and SMS and used it for AID. As mentioned above, longer stoppage times and smaller segments indicate that the speed of a car is decreasing rapidly and the SMS becomes larger compared with the TMS. During natural traffic congestion, a car operates at a comparatively slow speed throughout the whole section, or it operates by repeatedly slowing down and stopping. Therefore, the TMS and SMS are almost equal.

By contrast, if we consider a situation where a traffic accident occurs and the number of lanes available decreases before the accident, the speed of a car will fall rapidly and this can lead to a situation where a car must stop for a long time. However, the traffic condition becomes ideal after the accident point and the driver
can operate at their preferred speed because there is a decrease in the number of cars. Therefore, the SMS becomes larger compared with the TMS. This difference appears as a distance from the proportion line (lines in Figures 1, 2, and 3) for each car’s point on the TMS and SMS plots. This is an index that represents the speed “deviation” and it indicates the traffic state on a road section.

By contrast, if we consider a situation where a traffic accident occurs and the number of lanes available decreases before the accident, the speed of a car will fall rapidly and this can lead to a situation where a car must stop for a long time. However, the traffic condition becomes ideal after the accident point and the driver can operate at their preferred speed because there is a decrease in the number of cars. Therefore, the SMS becomes larger compared with the TMS. This difference appears as a distance from the proportion line (lines in Figures 1, 2, and 3) for each car’s point on the TMS and SMS plots. This is an index that represents the speed “deviation” and it indicates the traffic state on a road section.

Definition 3. Speed deviation: If $TMS_{i,X}$ and $SMS_{i,X}$ are the TMS and SMS of the $i$th car that passes through a road section $X$, respectively, the speed deviation of this car on $X$ is defined as follows.

$$dev_{i,X} = \frac{|TMS_{i,X} - SMS_{i,X}|}{\sqrt{2}}$$

Note that subscript $i$ stands for the order of cars that pass through the road section $X$. In other words, the $i$th car passes through the section $X$ earlier than $j$th car if $i < j$ holds.

This feature is extracted from two forms of speed collected using the same car, but it is less vulnerable to individual differences. Moreover, natural traffic congestion and abnormal traffic congestion can be distinguished by using this feature.

However, the use of this feature on its own is inadequate for AID. Figure 1 shows that multiple points are plotted far from the proportion line, so the SMS can be larger compared with the TMS during non-incident situation. Therefore, we analyze the traffic incident situation and exploit the temporal and spatial characteristics of traffic incidents.

### 3.3 Temporal Analysis

The traffic incident that occurred in the road section $X$ degrades the traffic state of $X$ rapidly. Figure 2 shows the TMS and SMS plots for four cars that passed through $ME3$ on the same day as that shown in Figure 1, before (o) and after (x) an accident. The points when the cars passed through the section before the accident differed in their absolute speed, but the distance from the proportion line was very small. By contrast, the distances from the proportion line for the points representing the cars that passed through the section after the accident are large. Thus, the rapid change in the traffic state on road section $X$ due to the traffic incident can be detected using $dev_{1,X}$ and $dev_{2,X}$.
3.4 Spatial Analysis

The traffic accident that occurred on road section $X$ had a significant effect on the downstream section of $X$. The TMS and SMS plots of the same cars that are shown in Figure 2, but on the downstream road section of $ME3$ are shown in Figure 3. The speed of the cars that passed through the section before the accident was comparatively low and this may be judged to be traffic congestion based on a threshold. By contrast, the TMS and SMS of the cars that passed through the section after the accident were high and almost equal. Thus, the decreased flow of cars in the downstream section of $X$ can be determined using $dev_{i,\text{down}X}$ and $TMS_{i,\text{down}X}$.

3.5 Feature Vector Space

In conclusion, the feature vector can be written as follows.

$$f_{i,X} = \left[ dev_{i-1,X}, dev_{i,X}, dev_{i,\text{down}X}, TMS_{i,\text{down}X} \right]$$

In this paper, this feature vector is very important and it is used for AID. Figure 4 shows the feature vector plot for the probe car that passed through $ME3$ between February 2011 and December 2011 ($TMS_{i,\text{down}ME3}$ is excluded to improve the presentation). Each point in Figure 4 corresponds to one car.

4. DETECTION METHOD

This section proposes a traffic incident-detection method based on the feature vector space described in the previous section.

4.1 Traffic Incident Condition

When a traffic incident occurs on road section $X$, $dev_{i,X}$ is expected to increase rapidly, whereas $dev_{i,\text{down}X}$ keeps small and $TMS_{i,\text{down}X}$ becomes large because the number of cars that flow into the downstream section of $X$ decreases. Using the thresholds $d_1$, $d_2$, $d_3$, and $v_{\text{min}}$, this is described as follows.

$$dev_{i-1,X} \leq d_1 \land dev_{i,X} \geq d_2 \land dev_{i,\text{down}X} \leq d_3 \land TMS_{i,\text{down}X} \geq v_{\text{min}}$$

Condition (5) defines a hyper-rectangle in the feature space that contains feature vectors of cars involved in the congestion caused by a traffic incident. Note that we use the different threshold $d_i$ for $dev_{i-1,X}$ and $d_2$ for $dev_{i,X}$. If the speed “deviation” becomes larger from a large state, it means the aggravation of the abnormal congestion. To distinguish the occurrence of a traffic incident from it, we consider the situation of small $dev_{i-1,X}$ and large $dev_{i,X}$ as well as sudden change of the “deviation”.
4.2 Determination of the Thresholds

The distribution of the “deviation” differs in each road section, so the thresholds need to be determined automatically based on past data for each road section. We use the well-known k-means algorithm to determine the thresholds. The list of \( \text{dev}_{i,X} \) and \( \text{dev}_{i,\text{down}X} \) observed in the past data is classified into four clusters. Intuitively, each cluster contains data where the “deviation” is close, fairly close, fairly distant, and distant from the origin. Let \( c_1, c_2, c_3, \) and \( c_4 \) be the central values of each cluster in ascending order.

If there are no incidents, the speed “deviation” does not increase because cars operate at almost the same speed throughout the whole section, or they operate while repeatedly slowing down and stopping. Thus, \( d_1 \) is set as follows.

\[
d_1 = \frac{c_2 + c_3}{2} \quad (6)
\]

After an accident, the “deviation” increases immediately. Therefore, we set \( d_2 \) as follows.

\[
d_2 = c_4 \quad (7)
\]

Because of the accident, the traffic state in the downstream section remains ideal and the “deviation” becomes very small. Thus, \( d_3 \) is set as follows.

\[
d_3 = \frac{c_1 + c_2}{2} \quad (8)
\]

Highways with a speed limit of 50[km/h] exist in Japan. Therefore, we use 50[km/h] as \( v_{\text{min}} \).

If each value of \( f_{i,X} \) satisfies the condition (5), \( f_{i,X} \) indicates that a traffic incident has occurred in road section \( X \) between the \((i - 1)\)th car and the \(i\)th car.

4.3 Detection of Other Anomalies

The information about other traffic anomalies such as continuing of abnormal traffic congestion or dissolution of it is also important for traffic management.

These traffic anomalies are detected by using other hyper-rectangle. The continuing of abnormal traffic congestion is detected by condition (9) and dissolution of it is detected by condition (10), respectively.

\[
\text{dev}_{i-1,X} \geq d_2 \land \text{dev}_{i,X} \geq d_2 \land \text{dev}_{i,\text{down}X} \leq d_3 \land TMS_{i,\text{down}X} \geq v_{\text{min}} \quad (9)
\]

\[
\text{dev}_{i-1,X} \geq d_2 \land \text{dev}_{i,X} \leq d_4 \quad (10)
\]

5. DETECTION METHOD

We evaluated the performance of our proposed method based on PCD in Tokyo.

5.1 Experiment Setting

The final aim of our research was the real-time detection of traffic incidents based on real-time PCD, so the evaluation was conducted using PCD between February 2011 and December 2011. We set the road section to include the point where each accident occurred based on road traffic census data [1].

In a real-time detection scenario, it is necessary to determine the thresholds in advance based on past data. Whenever a car passes through the target road section, \( f_{i,X} \) is updated and compared with the thresholds. Therefore, our method is applicable to stream data.

The number of PCs that passed through the target road section greatly changes by time and a road section. In addition, if two probe cars passed almost simultaneously, a change in the traffic state of the target road section could not be detected. Therefore, we set \( f_{i,X} \) and applied a detection technique where the difference between the time of the \((i - 1)\)th car and the \(i\)th car was less than 40 minutes, but more than 3 minutes. When evaluating the performance of AID, we regarded the detected feature vector \( f_{i,X} \) is correct if the time of the traffic accident on \( X \) was between the \((i - 1)\)th car and the \(i\)th car.
The detection rate (DR) and FAR are commonly used metrics for evaluating the performance of AID. However, we only had data related to three real accidents and other traffic incidents that occurred on each road section. All three accidents were detected correctly in each experiment, so we do not discuss the DR.

5.2 Incident Detection

We performed AID with the following three different types of detection rules on each road section.

- The rule defined by the condition (5). We refer to this rule as a \textit{tempo-spatial rule}.
- The rule defined by the condition (5), with the exception that \( \text{dev}_{i,\text{X}} \leq d_i \), which meant that traffic incidents were only detected when a car passed through the target road section. We refer to this rule as a \textit{spatial rule}.
- The rule defined by the condition (5), with the exceptions that \( \text{dev}_{i,\text{down}} \geq d_3 \) and \( \text{TMS}_{i,\text{down}} \geq v_{\text{min}} \), which corresponded to detecting incidents without any information from the downstream road section. We refer to this rule as a \textit{temporal rule}.

The number of false alarms (FAs) and the FAR for each road section in the different conditions are summarized in Table 1.

| Table 1. The number of FAs and FAR for each road section in the different conditions |
|-----------------------------------------------|-------------------|--------------------|--------------------|-------------------|
|                                              | Accident No. 1    | Accident No. 2    | Accident No. 3    | Total             |
|                                              | 2011/08/12 15:00  | 2011/09/18 07:00  | 2011/09/22 06:05  |                   |
|                                              | 3 Shibuya-sen Line| 4 Shinjuku-sen Line| 4 Shinjuku-sen Line|                   |
| Number of tests (\( f_{i,\text{X}} \))      | 30735             | 19097             | 14303             | 64135             |
| Number of FAs                                | 13                | 17                | 22                | 52                |
| FAR (%)                                       | 0.04              | 0.09              | 0.15              | 0.08              |
| Number of FAs                                | 33                | 61                | 66                | 160               |
| FAR (%)                                       | 0.11              | 0.32              | 0.46              | 0.25              |
| Number of FAs (temporal rule)                | 57                | 27                | 88                | 172               |
| FAR (%)                                       | 0.19              | 0.14              | 0.62              | 0.27              |

The characteristics of the road section affected the detection performance. All three road sections carried heavy traffic, but the traffic state on road sections No. 1 and No. 2 rarely changed rapidly because they were located away from the center of Tokyo. By contrast, road section No. 3 was located in the center of Tokyo and the traffic state of this section changed frequently because there were many entrances and junctions. Thus, the FAR of road section No. 3 was higher than the others.

The \textit{spatial rule} drops the condition regarding temporal relationship. By comparing the metrics listed in the rows of the \textit{tempo-spatial rule} and \textit{spatial rule} in Table 1, we can see that the temporal relationship is effective to decrease FAR significantly.

On the other hand, the \textit{temporal rule} drops the condition regarding spatial relationship. By comparing the metrics listed in the rows of the \textit{tempo-spatial rule} and \textit{temporal rule} in Table 1, we can see that the spatial relationship is also effective to decrease FAR significantly.

We mention that some of the FAs may have been correct answers and the true FAR could have been lower because there were other traffic incidents on each road section.

5.3 Other Anomalies

We also conducted the experiment for detection of other anomalies using condition (9) and condition (10). We had the detailed information about the influence of the accident No.1. One lane was closed to traffic by this accident and it continued till 17:30.

All \( f_{i,\text{X}} \) generated while one lane was closed satisfied the condition (9), and was reported as continuing of abnormal traffic congestion. Moreover, \( f_{i,\text{X}} \) first generated after the end of closure fulfilled the condition (10), and was reported as dissolution of abnormal traffic condition. From this, we can say that our technique has caught change of a traffic state of a road well.
Table 2. Comparison results

<table>
<thead>
<tr>
<th></th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tests $(f_{ik})$</td>
<td>30735</td>
<td>19097</td>
<td>14303</td>
<td>64135</td>
</tr>
<tr>
<td>Proposed method</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of FAs</td>
<td>13</td>
<td>17</td>
<td>22</td>
<td>52</td>
</tr>
<tr>
<td>FAR (%)</td>
<td>0.04</td>
<td>0.09</td>
<td>0.15</td>
<td>0.08</td>
</tr>
<tr>
<td>Zhu et al. [13]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of FAs</td>
<td>57</td>
<td>31</td>
<td>46</td>
<td>134</td>
</tr>
<tr>
<td>FAR (%)</td>
<td>0.19</td>
<td>0.16</td>
<td>0.32</td>
<td>0.21</td>
</tr>
</tbody>
</table>

5.4 Comparison

In order to show that our proposed feature is less subject to the individual difference, and can distinguish natural traffic congestion and abnormal traffic congestion, we conducted comparative experiment with the technique of Zhu et al. [10]. Although they also use the temporal and spatial characteristics of incidents which resembled ours, average speed is used as feature. The comparison results are shown in Table 3. It was shown that our proposed feature can capture the traffic state on a road better than average speed.

6. CONCLUSION

In this paper, we proposed an AID method based on PCD. Probe cars produce large-scale, cost-effective data. Existing AID algorithms only use the traveling time or average speed for incident detection, but it is difficult to distinguish abnormal traffic congestion from natural traffic congestion. To overcome this problem, we used the speed “deviation” to capture traffic state on a road. Our method was tested using real traffic incident data. The evaluation results showed that our proposed method detected each incident correctly with an average FAR of 0.08% or less, which shows that our method could be practiced effectively.

We used PCD including only three incidents for evaluation. To make the characteristics of the proposed method clear, we plan to gather more incident data. Currently we use the k-means clustering to determine the thresholds. We plan to extend this module in two ways. First, we apply other clustering techniques to find good thresholds. Second, we adaptively modify the thresholds by applying online clustering algorithms.

REFERENCES

A SELF-EFFICACY THEORY IN OPERATIONAL EFFICIENCY IMPROVEMENT OF HUMAN RESOURCE INFORMATION SYSTEMS

O. Akeem Adenuga\textsuperscript{1} and Ray M. Kekwaletswe\textsuperscript{2}

\textsuperscript{1}Department of Informatics, Tshwane University of Technology - South Africa
\textsuperscript{2}Information Systems Department, University of the Witwatersrand - South Africa

ABSTRACT
Despite the widespread use of computer-based human resource information systems (HRIS), previous research has not identified the conditions that support successful systems. To this point this paper addresses that gap, by presenting the results of a survey of users who interact directly with a computer-based HRIS to do their work. The paper examines self-efficacy theory and the hypotheses were formed with respect to individual/task, organizational, and HRIS application. The hypotheses were tested and the results indicate that these hypothesized conditions were significant for successful usage of HRIS. Overall, the findings of the study provide support towards a model of HRIS success and present a basis for planning, designing, and implementing successful HRIS systems.

KEYWORDS
Human resource information systems, Self-efficacy theory, human resource management, information systems

1. INTRODUCTION
The record of human resource management as it is seen in (Pilbeam and Corbridge, 2006, Boddy et al., 2005, Johnson et al., 2008, Kansal, 2008, Ward and Peppard, 2004,) can be traced back to the 1930s. The relationship among human resource management (HRM), information systems (IS) and information technology (IT) (Beardwell & Claydon, 2010, Holtsnider and Jaffe, 2010, Kavanah and Thite, 2009, Porter, 1990) may be attributed to the effectiveness and the management of human resource information system (HRIS). Increased use of HRIS according to (Hussain et al., 2006) allows professional to achieve improved performance and thus facilitates participation of activities within the organization. This paper is outlined as follows: firstly, literatures and efforts in these disparate fields is discussed; this is followed, by related works; the data collection method is then the section that follows in section 3 and 4. Section 5 concludes the research and recommendation are made.

2. RELATED WORKS
Ball (2001) claims that IT in HRM began in the 1960s with; personnel management office automation in payroll, benefits, administration and other transaction processing applications such as record holding. Ball adds that reasons for low level usage have been thought to stem from various factors in the environment of an HR department: elements such as organizational size, HRISs time in use, culture, strategy, power and politics. Haines and Petit (1997) view is similar to Ball but they base their argument on two measures of Information Systems (IS) field of inquiry, the two fields of inquiry are user satisfaction and system usage. They affirm that user satisfaction is based on attitudes and beliefs; system usage is based on behaviors. Eddy et al. (1999) looked at the effects of information management policies on reactions to human resource information systems. Their discussion on the rise of the use of HRIS which is essential for human resource planning that will enable human resource managers to achieve their business-related goals. Thus, human resource managers’ abilities to monitor the workforce, produce reports, utilize
employee skills effectively, and reduce labor costs. Snell (1992) study examined the relationship between strategic contexts in product-market variation, work flow integration, and firm size. Snell study inch further by looking at behavior and output control through human resource management control systems. Hussain et al., 2007 effort introduce a taxonomy that provides a framework for academic discussion and comparison. This is similar to the present study, which addresses self-efficacy theory in operational efficiency improvement of HRIS. The disparity between this research and earlier research is in the context.

2.1 Self-Efficacy Theory, Conceptual Framework and Hypotheses

Self-efficacy refers to people’s beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives (Bandura 1977, 1989, 1997). Bandura (1998) define self-efficacy as the conviction that can successfully execute the behavior required to produce certain outcomes. The definition concern is clearly on control over the behavior itself, not with control over outcomes or events. Bandura, 1977 self-efficacy theory suggests that there are four sources used by individual’s self-judgments in forming self-efficacy: they are performance accomplishments – link to past experiences in performing a specific task. (1) Previous successes – this raise mastery expectations, this is lowered by failures according to the following literatures (Saks, 1995; Gist and Mitchell, 1992). (2) Vicarious experience this is gained by observing others performing certain activities successfully. Experience by individuals can achieve by observing others perform certain activities over time (Bandura, 1978; Gist and Mitchell, 1992). (3) Social persuasion – this are activities where people are led, through suggestion, into believe that they can cope successfully with specific tasks. Social persuasion is achieved through coaching and giving evaluative feedback (Bandura and Cervone, 1986; Bandura, 1977). (4) Physiological and emotional states – self-efficacy can be judge with regards to performing certain tasks, whereby emotional reactions such as anxiety could lead to negative judgment of one’s ability to complete the tasks (Bandura, 1998). In order to achieve self-efficacy in HRIS usage, this study will test the hypotheses below:

![Conceptual Framework](image)

**Figure 1. Conceptual Framework**

2.2 Research Method and Data Analysis

The study made use of survey as its main instrument for the collection of data. The data collection obtains information from random sampling of the population. The study population comprised selected HRIS experts based in the UK. The experts are university graduates that have been trained by their various companies in order to work with the ERP application. The HRIS experts were fielded with questions on the adoption and usage of HRIS.

There were 44 participants in total and 8 participants are missing on one or more variables. Multiple regression is employed for data analysis as it uses only the participants who have completed data for all the variables. The table is use to analyze the complex association between the dependent variable (efficiency and effectiveness) of using HRIS and variables such as educational background, the position of the participant and the years of experience.
Table 1. Dependent Variable: Efficiency_Effective

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>5.705a</td>
<td>5</td>
<td>1.141</td>
<td>17.032</td>
<td>.000</td>
<td>.691</td>
</tr>
<tr>
<td>Intercept</td>
<td>22.075</td>
<td>1</td>
<td>22.075</td>
<td>329.547</td>
<td>.000</td>
<td>.897</td>
</tr>
<tr>
<td>Position</td>
<td>.401</td>
<td>3</td>
<td>.134</td>
<td>1.997</td>
<td>.131</td>
<td>.136</td>
</tr>
<tr>
<td>YearofExperience</td>
<td>1.972</td>
<td>1</td>
<td>1.972</td>
<td>29.445</td>
<td>.000</td>
<td>.437</td>
</tr>
<tr>
<td>Position * YearofExperience</td>
<td>.097</td>
<td>1</td>
<td>.097</td>
<td>1.454</td>
<td>.235</td>
<td>.037</td>
</tr>
<tr>
<td>Error</td>
<td>2.545</td>
<td>38</td>
<td>.067</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>77.000</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>8.250</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .691 (Adjusted R Squared = .651)

Statistically shown in table 3, tests of between subjects effects F(1,38) = 1.45, p = 0.24. This means that the "efficiency and effective" use of HRIS depends on position and the years of experience working with the application. The ANOVA shows the effect of selecting the participants at random. Table 2 and 3 report the positive effect caused by the independent variables. This finding supports Hypothesis 1, which states that experience and training in working with HRIS impact positively on operational efficiency of HRIS.

Table 2. Correlations

<table>
<thead>
<tr>
<th></th>
<th>Position</th>
<th>Efficiency_Effective</th>
<th>Management_Decimal</th>
<th>Training</th>
<th>Application_of_HRIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.441**</td>
<td>.418**</td>
<td>.278</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.003</td>
<td>.005</td>
<td>.068</td>
<td>.755</td>
</tr>
<tr>
<td>Efficiency_Effective</td>
<td>Pearson Correlation</td>
<td>.441**</td>
<td>1</td>
<td>.707**</td>
<td>.610**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.003</td>
<td>.000</td>
<td>.000</td>
<td>.067</td>
</tr>
<tr>
<td>Management_Decimal</td>
<td>Pearson Correlation</td>
<td>.418**</td>
<td>.707**</td>
<td>1</td>
<td>.571**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.005</td>
<td>.000</td>
<td>.000</td>
<td>.016</td>
</tr>
<tr>
<td>Training</td>
<td>Pearson Correlation</td>
<td>.278</td>
<td>.610**</td>
<td>.571**</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.068</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Application_of_ERP</td>
<td>Pearson Correlation</td>
<td>.048</td>
<td>-.279</td>
<td>-.362**</td>
<td>-.771**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.755</td>
<td>.067</td>
<td>.016</td>
<td>.000</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Looking at the correlation table we make our assumption based on high and low correlations between the variables in the table; the correlation between efficiency and effective use of HRIS in operational efficiency improvement (.707). Therefore, we make an observation on this correlation in the ANOVA since there were correlations between .60 and higher. The test of between subject effects are identical to the three separate univariate one-way ANOVA which could have been an option if we choose not to do ANOVA. The position, efficiency and effective, management decision, training and application of ERP are statistically significant on decision of return on investment. The multivariate and univariate tests present the measures of effect size (eta squared). The multivariate test for the square root of (0.275, 0.701, 0.048).
0.614, 0.531, and 0.323) is (0.52, 0.84, 0.78, 0.73, and 0.57) for effect of position, efficiency and effective, management decision, training and application of ERP respectively. All the effect of these variables is high making the variables significant in the determination of operational efficiency in improvement of HRIS. The Parameter Estimates advise us on how the dependent variables are weighted in the equation which maximally differentiates the groups. Return on investment which is the fixed factor is the dependent variable in this context.

It appears that the ANOVA and the Parameter Estimates table results is used to determine whether there are variation on each of the variables when examined alone. The variation will help us to determine whether multi-collinearity of the results is affected. The ANOVA additionally help us to appreciate the variables, separately as they differ across groups. The table 4, 5 and 6 reports the correlation, test of between subject effects, parameter estimate for return on investment on the following variables: position, efficiency and effective, management decision, training and application of ERP. This finding supports Hypothesis 2 and Hypothesis 3 which states Job satisfaction/success in working with HRIS impact positively on operational efficiency of HRIS, and ability to cope in working with HRIS impact positively on operational efficiency of HRIS.

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>Position</td>
<td>8.407</td>
<td>2</td>
<td>4.204</td>
<td>7.785</td>
<td>.001</td>
<td>.275</td>
</tr>
<tr>
<td></td>
<td>Efficiency_Effective</td>
<td>5.782</td>
<td>2</td>
<td>2.891</td>
<td>48.034</td>
<td>.000</td>
<td>.701</td>
</tr>
<tr>
<td></td>
<td>Management_Decision</td>
<td>5.356</td>
<td>2</td>
<td>2.678</td>
<td>32.574</td>
<td>.000</td>
<td>.614</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>3.124</td>
<td>2</td>
<td>1.562</td>
<td>23.191</td>
<td>.000</td>
<td>.531</td>
</tr>
<tr>
<td></td>
<td>Application_of_ERP</td>
<td>4.528</td>
<td>2</td>
<td>2.264</td>
<td>9.801</td>
<td>.000</td>
<td>.323</td>
</tr>
<tr>
<td>Intercept</td>
<td>Position</td>
<td>169.776</td>
<td>1</td>
<td>169.776</td>
<td>314.426</td>
<td>.000</td>
<td>.885</td>
</tr>
<tr>
<td></td>
<td>Efficiency_Effective</td>
<td>60.101</td>
<td>1</td>
<td>60.101</td>
<td>998.537</td>
<td>.000</td>
<td>.961</td>
</tr>
<tr>
<td></td>
<td>Management_Decision</td>
<td>60.959</td>
<td>1</td>
<td>60.959</td>
<td>741.429</td>
<td>.000</td>
<td>.948</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>47.935</td>
<td>1</td>
<td>47.935</td>
<td>711.583</td>
<td>.000</td>
<td>.946</td>
</tr>
<tr>
<td>Return_on_Investment</td>
<td>Position</td>
<td>8.407</td>
<td>2</td>
<td>4.204</td>
<td>7.785</td>
<td>.001</td>
<td>.275</td>
</tr>
<tr>
<td></td>
<td>Efficiency_Effective</td>
<td>5.782</td>
<td>2</td>
<td>2.891</td>
<td>48.034</td>
<td>.000</td>
<td>.701</td>
</tr>
<tr>
<td></td>
<td>Management_Decision</td>
<td>5.356</td>
<td>2</td>
<td>2.678</td>
<td>32.574</td>
<td>.000</td>
<td>.614</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>3.124</td>
<td>2</td>
<td>1.562</td>
<td>23.191</td>
<td>.000</td>
<td>.531</td>
</tr>
<tr>
<td></td>
<td>Application_of_ERP</td>
<td>4.528</td>
<td>2</td>
<td>2.264</td>
<td>9.801</td>
<td>.000</td>
<td>.323</td>
</tr>
<tr>
<td>Error</td>
<td>Position</td>
<td>22.138</td>
<td>41</td>
<td>.540</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency_Effective</td>
<td>2.468</td>
<td>41</td>
<td>.060</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management_Decision</td>
<td>3.371</td>
<td>41</td>
<td>.082</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>2.762</td>
<td>41</td>
<td>.067</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application_of_ERP</td>
<td>9.472</td>
<td>41</td>
<td>.231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Position</td>
<td>240.000</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency_Effective</td>
<td>77.000</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management_Decision</td>
<td>80.000</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>65.000</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application_of_ERP</td>
<td>58.000</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>Position</td>
<td>30.545</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency_Effective</td>
<td>8.250</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management_Decision</td>
<td>8.727</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>5.886</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application_of_ERP</td>
<td>14.000</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
a. $R^2 = .275$ (Adjusted $R^2 = .240$)
b. $R^2 = .701$ (Adjusted $R^2 = .686$)
c. $R^2 = .614$ (Adjusted $R^2 = .595$)
d. $R^2 = .531$ (Adjusted $R^2 = .508$)
e. $R^2 = .323$ (Adjusted $R^2 = .290$)

Table 4. Dependent variable parameter

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Intercept</td>
<td>2.714</td>
<td>.278</td>
<td>9.773</td>
<td>.000</td>
<td>2.153 - 3.275</td>
<td>.700</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=1]</td>
<td>-.811</td>
<td>.307</td>
<td>-2.638</td>
<td>.012</td>
<td>-1.432 - -.190</td>
<td>.145</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=2]</td>
<td>2.86</td>
<td>.409</td>
<td>.699</td>
<td>.489</td>
<td>-.540 - 1.111</td>
<td>.012</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=3]</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Efficiency_Effective</td>
<td>Intercept</td>
<td>2.000</td>
<td>.093</td>
<td>21.569</td>
<td>.000</td>
<td>1.813 - 2.187</td>
<td>.919</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=1]</td>
<td>-.968</td>
<td>.103</td>
<td>-9.426</td>
<td>.000</td>
<td>-1.175 - -.760</td>
<td>.684</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=2]</td>
<td>.500</td>
<td>.136</td>
<td>-3.663</td>
<td>.001</td>
<td>-.776 - -.224</td>
<td>.247</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=3]</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Management_Decision</td>
<td>Intercept</td>
<td>2.000</td>
<td>.108</td>
<td>18.454</td>
<td>.000</td>
<td>1.781 - 2.219</td>
<td>.893</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=1]</td>
<td>-.935</td>
<td>.120</td>
<td>-7.796</td>
<td>.000</td>
<td>-1.178 - -.693</td>
<td>.597</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=2]</td>
<td>.500</td>
<td>.160</td>
<td>-3.134</td>
<td>.003</td>
<td>-.822 - -.178</td>
<td>.193</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=3]</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Training</td>
<td>Intercept</td>
<td>1.714</td>
<td>.098</td>
<td>17.475</td>
<td>.000</td>
<td>1.516 - 1.912</td>
<td>.882</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=1]</td>
<td>-.714</td>
<td>.109</td>
<td>-6.577</td>
<td>.000</td>
<td>-.934 - -.495</td>
<td>.513</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=2]</td>
<td>.381</td>
<td>.144</td>
<td>-2.638</td>
<td>.012</td>
<td>-.673 - -.089</td>
<td>.145</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=3]</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Application_of_ERP</td>
<td>Intercept</td>
<td>.286</td>
<td>.182</td>
<td>1.573</td>
<td>.123</td>
<td>-.081 - .653</td>
<td>.057</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=1]</td>
<td>.811</td>
<td>.201</td>
<td>4.032</td>
<td>.000</td>
<td>.405 - 1.217</td>
<td>.284</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=2]</td>
<td>1.048</td>
<td>.267</td>
<td>3.918</td>
<td>.000</td>
<td>.508 - 1.588</td>
<td>.272</td>
</tr>
<tr>
<td></td>
<td>[Return on Investment=3]</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

In order to analyze this we assume the dependent variable to be dichotomous, which is efficient but not effective. We employ discriminant analysis to be appropriate for this analysis. Therefore, table below shows the logistic regression.
Table 5. Variables in the Equation

<table>
<thead>
<tr>
<th>Step 1</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
<th>95% C.I. for EXP(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Upper</td>
</tr>
<tr>
<td>1a</td>
<td>User_Friendly</td>
<td>-56.730</td>
<td>11583.167</td>
<td>.000</td>
<td>1</td>
<td>.996</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Job_Description</td>
<td>-.467</td>
<td>1.679</td>
<td>.077</td>
<td>1</td>
<td>.781</td>
<td>.627</td>
</tr>
<tr>
<td></td>
<td>Return_on_Investment</td>
<td>57.509</td>
<td>11583.167</td>
<td>.000</td>
<td>1</td>
<td>.996</td>
<td>9.458E-24</td>
</tr>
<tr>
<td></td>
<td>Recommendation</td>
<td>-19.785</td>
<td>4388.019</td>
<td>.000</td>
<td>1</td>
<td>.996</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>-.236</td>
<td>4.838</td>
<td>.002</td>
<td>1</td>
<td>.961</td>
<td>.790</td>
</tr>
</tbody>
</table>

a. Variable(s) entered on step 1: User_Friendly, Job_Description, Return_on_Investment, Recommendation.

Education, training and years of experience in relation to using HRIS application are significant predictors when all the four variables are considered together. Correlation among the predictors such as job description is not significant in predicting the effective and efficiency of HRIS application whether alone or in combination with other predictors (Table 5).

The variable to be included in the equation for the model shows that three out of the four variables (user friendly, job description, return on investment and recommendation) are, individually, significant predictors of effectiveness and efficiency in relation to the use of HRIS application. User friendly and recommendation are not significant in predicting the operational efficiency in improvement of HRIS. The reasons are due to:

1. The SE is too high in relation to B;
2. The dichotomous nature of user friendliness of using the application and making recommendation in the use of HRIS as this has no effect on efficiency of using HRIS;

It is significant to take note of EXP (B) as this give odd ratio for the variable job description. The odd ratio and confidence of interval for job description is (95% CI = 16.853 – 0.023). This is too high and therefore will not be important in the prediction of the percentage of effect of this variable. Thus, conducting a logistic regression to assess whether the four predictor variables user friendly, job description, return on investment and recommendation, are not significant in predicting whether or not these variables when applied in predicting operational efficiency improvement for HRIS. Table 5 reports is on the variables in the equation, this finding supports Hypothesis 4, which states that involvement and communication in working with HRIS impact positively on operational efficiency of HRIS.

2.3 Study Limitation

Although the study seeks to explore self efficacy theory in operational efficiency improvement of HRIS, but it will not attempt all aspect HRIS as it is used in HR activities. Also, the study is only limited to HRIS experts in the UK which could not be use to generalize for the operational efficiency in other countries. The study was unable to sample the total population of HR professionals directly involved in the usage of HRIS to enhance their activities in the UK. There is no means of testing for adequacy in the sampled population or nonresponse bias as we use perceptual measures for theoretical constructs. The HRIS framework and constructs might be refined in the future research in terms of operational efficiency.

3. CONCLUSION

This paper argued that human resource management practices should harnessed information systems theories to attain competitive position in organizations. The focal point in strategic management signify essential shift in the human resource management agenda. The paper moves towards a model of individual behavior in information systems application usage in organizations. Evolution of strategic human resource information systems, therefore, requires interdisciplinary research. To-date, the unfortunate obsession is that majority of studies has been conceptual in nature. Fisher (1989) pointed out that, although ideas and anecdotes certainly have merit, the truest test comes through empirical research.
This paper tested a self-efficacy theory to complement the behavioral perspective on strategic human resource management. The findings are directly useful to human resource researchers, information system experts and others interested in strategy and control. This integration effort in two disciplines examines potential benefits for the field of management of human resources and information systems.

REFERENCES


CLASSIFICATION RULES FOR REQUIREMENTS
OBSERVATION

Takako Nakatani¹, Toshikazu Sano¹, Michitaro Okano¹, Narihito Kondo², Yukiko Fujiwara³, Ryu Nakazato⁴, Mari Inoki⁵, Shozo Hori⁶, Toshihiko Tsumaki⁷, Michio Tsuda⁸ and Keiichi Katamine⁹
Univ. of Tsukuba - 3-29-1, Otsuka, Bunkyo, Tokyo, 112-0012, Japan¹
Nagoya Management Junior College²
Knowledge Discovery Research Laboratories, NEC³
Software Engineering Center, TOSHIBA Corporation⁴
Advanced IT Laboratory, Toshiba Solutions Corporation⁵
YASKAWA Information Systems Corporation⁶
National Institute of Informatics⁷
Osaka University⁸
Kyushu Institute of Technology⁹

ABSTRACT

The purpose of our research is to enable the management of the requirements elicitation process. To manage something, we first have to observe it quantitatively. Therefore, to manage the requirements elicitation process, we must observe the process quantitatively. We are currently trying to observe requirements quantitatively in accordance with their categories. In general, requirements are classified into two categories: functional and non-functional. The requirements categories can be refined to more adequately observe them. We defined the taxonomy of requirements. In this paper, the classification rules of words in requirements are proposed. A prototype tool was developed, and named the “requirements counting tool (RCT),” with classification rules and morphological analysis. The rules were evaluated by comparing the results of the RCT and manual classification with the logrank test. In the paper, the results are shown, and the adequacy of the rules is confirmed.

KEYWORDS

Requirements elicitation, requirements maturation, quantitative observation

1. INTRODUCTION

1.1 Background and Motivations

There are several ways to cope with requirements volatility. One is risk management (Sakthivel 2010, Singh 2012), and another is negotiation (Davis 2005, Khurum 2007). Our challenge is to manage the requirements elicitation process, rather, control the requirements' volatility (Ting 2011). Loconsole et al. defined the term "volatility" as the amount of changes to a use case model over time (Loconsole 2005). They showed that there is significant correlation between the size of a change to the use case model and the size of the use case model. Our way is to consider "volatility" as one of the phenomena of requirements elicitation after the design phase has begun. In this context, we need not distinguish among the addition, deletion, and modification of requirements.

The history of requirements changes has been observed by several researchers. Kousik et al. (Kousik 2007) clarified that 70% of final requirements were not elicited in the early phase of a project. Requirements changes can be classified by their origins (Strens 1996). If we can identify the types, reasons, and origins of the changes, we may be able to control the volatile requirements (Nurmuliani 2004). There is a process for assessing requirements stability (Bush 2003). The approaches of these pieces of research focus on the causes and/or effects of requirements changes. As we mentioned above, we do not distinguish between the volatility
of requirements and elicitation of requirements. In this paper, we focus on categories of stable and/or volatile requirements themselves since we believe that the requirements maturation process depends on the requirements categories, of which, characteristics cause elicitation difficulties, as well as volatility/stability.

Here, "requirements maturation" refers to how many requirements within the category are elicited completely. When one hundred percent of the requirements are elicited, we consider the category’s requirements to have matured. The requirements maturation rate by time t, \( RMR(t) \), is measured by using the following formula (Nakatani 2011).

\[
RMR(t) = \frac{R(t)}{R_T}
\]

In this formula, \( R(t) \) is the cumulative number of requirements, that is, added requirements, deleted requirements, and modified requirements from the initial time of the project to the time, \( t \). \( R_T \) is the cumulative number of requirements during the project. This means that every category’s requirements can mature by the end of the project. We are currently trying to observe requirements quantitatively within their assigned categories. In accordance with our quantitative observations (Nakatani 2010), some requirements were elicited even in the integration test phase. Some kinds of categories have their own requirements maturation period.

1.2 Purpose

When we observed requirements elicitation processes in our previous work, we categorized requirements and counted them by hand, which in the final assessment, was costly and time consuming. To improve the productivity of observation, a tool support or automatic categorization system is required. In this paper, we propose classification rules for such a system. The classification rules are rules for mapping from a word to a category.

The taxonomy of requirements was proposed in (Nakatani 2011). Basically, requirements are classified into two categories: functional requirements (FRs) and non-functional requirements (NFRs). FRs depend on the software being developed and its domain. In contrast, NFRs depend on domain independent words. To develop widely accepted classification rules, we focus mainly on NFRs in this paper. For NFRs, eight categories are defined in the taxonomy. One of them is TypeC. The requirements belonging to TypeC are requirements that constrain the development process and product, as well as the project. The other seven categories are based on the standard of the Software Product Quality Requirements (ISO/IEC 25000). They are: functionality (TypeF), security (TypeS), reliability (TypeR), usability (TypeU), efficiency (TypeE), maintainability (TypeM), portability (TypeP).

The classification rules are evaluated with the logrank test (Kleinbaum 2005) which analyzes the survival distributions of two data sets. The logrank test is popularly used in clinical trials to establish/modify the efficiency of a new treatment by comparing it with a control treatment. When we analyzed 677 communication records within the minutes of a project in two ways, we applied the logrank test to compare their results. One way was supported by an analysis tool that we developed, while the other way was through manual analysis. The tool was developed to analyze a set of sentences, and has three functions: (1) extract words from each timed sentence in a document with a morphological analysis, (2) classify words into requirements categories with the classification rules, and (3) count the number of requirements in each category by time. The name of the tool is the requirements counting tool (RCT).

This paper is organized as follows. Section 2 presents the classification rules necessary to count the number of requirements belonging to each category. Section 3 shows the results of analysis and the logrank test. We also discuss the strengths and weaknesses of the classification rules and the RCT. In section 4, we conclude this paper.

2. CLASSIFICATION RULES

First of all, the classification rules are rules for mapping from a word to a category. When we developed the classification rules of FRs and NFRs, there were two possible ways. One is selecting the words from the minutes of a project. Those words may be domain specific words rather than domain independent words. For example, the word "guestID" was used as a temporal user ID in the minutes. Statements with the words "guestID" described the security requirements. However, "guestID" may not be a general term. The other
way is to find words from the descriptions in more general documents. NFRs do not depend on problem domains. For example, the IPA/SEC provided the NFRs grade (IPA/SEC 2010).

The NFRs grade is defined as a guideline for designing the NFRs of a system being developed. With the NFRs grade, it is assumed that every system can be categorized into three models: systems with a very significant social impact, systems with a limited social impact, and systems with no social impact. The grade guides users in defining the quantitative level of each NFR in order to satisfy the social responsibility of the systems they are developing. The users of the NFRs grade refer to the grade table and compare the NFRs of their system with the levels of the NFRs of the model systems that are similar to their system. For example, 99%, 99.99%, and 99.999% of the uptime ratio is acceptable for a system with almost no social impact, limited social impact, and very significant social impact, respectively. The acceptance ratio of other non-functional requirements is provided for each model system. Therefore, the NFRs grade is regarded as an adequate document from which we extract key words, e.g., digital signatures, passwords, firewalls, malware, etc.

Both the minutes and the guideline are written in natural language. To find words from those documents, we applied a morphological analysis and explored key words. When we developed the classification rules, we determined the categories of each key word with the Delphi method (Linstone 1975) which is a method for making a decision by using a vote basis.

The authors discussed whether the words are key or not. Then, the classification rules were constructed. The classification rules consist of the key words and the requirements categories. Each word is mapped to related requirements categories. Thus, the classification rules make it possible to observe requirements elicitation processes.

The observation process:
1. Parse the minutes into a set of statements.
2. Apply a morphological analysis to each statement and select words consistent in the statement.
3. Map each word to the requirements categories. Thus, one statement may be mapped to multiple categories.
4. Sum up the requirements mapped to each category.

One of the strengths of this process is the possibility of being supported by an Excel based tool. It also improves the productivity of observation. Furthermore, adding or deleting words to the classification rules is simple and easy. The weaknesses are:
- If a new statement is added, the user has to update the rules. However, steps (1) to (3) can help users to solve this problem.
- The minutes may contain a lot of ambiguous words and uncertain statements. To solve this problem, standard word sets, standard statement templates, or a guideline of minutes should be provided to users when they write their minutes.

Part of the classification rules are shown in Table 1. Because of a lack of space, the table shows the classification rules as a map from each category to the words. However, the real classification rules are used to map from words to categories. We regard the productivity of observation and the simplicity of the procedure as more important than completeness. We can improve the preciseness of the classification rules by applying our approach to real projects. The words related to TypeU will be added from the NFRs grade in our future work.

3. EVALUATION

In this chapter, we introduce the applying process of the tool for categorizing requirements, named "RCT." Then, we describe a document we analyzed. After that, the results of the analysis will be shown and discussed.

3.1 Requirements Categorizing Tool

The RCT consists of five functions and used by a following process.
1. Extracting words from the minutes of a project with morphological analysis. This function is implemented by using MeCab (Kudo 2004), a Japanese morphological analyzer.
Table 1. Classification rules (part)
(Note: The words in this table were translated from Japanese words. There is not one-to-one correspondence between Japanese words and English words.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Words in the minutes</th>
<th>Words in the NFRs grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Interface</td>
<td>error message, scroll bar, slider, top page, pull down, icon, character, graphics, picture, click, box, menu, button, resolution, title, the number of characters, UI, print, line, screen, scaling, zooming,...</td>
<td>-</td>
</tr>
<tr>
<td>External Interface</td>
<td>internet, interface, html, http, file, CSV, FTP, OCR, OMR,...</td>
<td>-</td>
</tr>
<tr>
<td>Scenario Control</td>
<td>every time, transform, frequency, forward, send, sequence, process, in advance, start, avoid, all together, reload, realtime, merge, batch, daily reminder, download, timing, START, STOP</td>
<td>-</td>
</tr>
<tr>
<td>Replacement</td>
<td>replace, keep, existing, the present state, no change</td>
<td>-</td>
</tr>
<tr>
<td>Variability</td>
<td>which, compatible, customization, option, alternative, both of, coexistence</td>
<td>-</td>
</tr>
<tr>
<td>Reuse</td>
<td>compatible</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>guestID, ID, session, security, account, password, access, login, parole, SSO, masquerade, permission, authority, certification</td>
<td>authentication, network diagnostics, security diagnostics, restrictions, firewall, fraud, confidentiality, digital signature, web site diagnostics, DB diagnostics, password, room access, monitoring camera, attack,...</td>
</tr>
<tr>
<td>Reliability,</td>
<td>check, session</td>
<td>24hours, 365days, availability, reliability, outage, journal, integrity, backup, real-time, alternative, operation, switchover, restore, mirroring, RAID, disaster, recovery, fault, failure,...</td>
</tr>
<tr>
<td>Availability</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Usability</td>
<td>usability, smooth, wrong feeling, automatically, effort, convenient</td>
<td>-</td>
</tr>
<tr>
<td>Efficiency</td>
<td>real time, efficiency, tuning, approximately load, maximum, MAX, more than, MB, capacity, volume, slow</td>
<td>throughput, turnaround time, transaction, response, the number of clients, the number of simultaneous users, the number of users, the number of batch processes, the number of business functions, the number of requests, the number of servers, scale out, scale up, business processing volume, business volume, volume of data,...</td>
</tr>
<tr>
<td>Maintainability</td>
<td>maintenance, operation, reload, support, night time, utilization</td>
<td>server software, security patch, incident management, system fault detection handling, data loss, patch application policy, support, system renewal, backup, log, restart, recovery, configuration management, time synchronization, failure, fault, monitoring, inspection,...</td>
</tr>
<tr>
<td>Portability</td>
<td>compatible</td>
<td>migration, data media type, simultaneous deployment, conversion rule, rehearsal, backup, connection specification, switchover, rollback, production system,...</td>
</tr>
</tbody>
</table>
(2) (Manual) Defining classification rules by analyzing the extracted words. The words and their categories are registered as the classification rules.
(3) Analyzing sentences in the minutes and categorizing them to the requirements categories with the classification rules.
(4) Counting the number of requirements in each category by time.

The RCT was developed as a prototyping system with macro in Excel. Figure 1 shows the RCT process.

3.2 Case Study: HInT

HInT was developed at Hannan University, Japan. HInT is a communication support system by which students can access lecture information and class schedules, as well as various service information provided by the university via the internet. We collected ten minutes from October to December in 2007. There were 677 sentences in those minutes, and 1266 words and characters were extracted with the RCT. However, 1052 words (approximately 83% of 1266 words) were ignored as key words in the classification rules. For example, adverbs, adjectives, numbers, dates, and single characters were ignored since each word or character does not represent the category of the requirement but simply the requirement details. Furthermore, some of those words were ambiguous. For example, "next" was used in the sentence "the next operation" and also in the sentence "in the next meeting." Hence, such kinds of vague words, except for verbs, cannot be registered as key words in the classification rules.

The classification rules were combined with 214 words from the HInT’s minutes and 370 words from the NFRs grade. After eliminating redundant words, the classification rules contained 581 words. Some words were mapped to multiple categories. The detailed items are shown in Table 2. The number of sentences classified by manual and the RCT is also shown. Notice that one sentence includes multiple words: thus, some sentences may be classified into multiple classification types.

### Table 2. Detailed items in the classification rules and number of classified sentences

<table>
<thead>
<tr>
<th>Classification Types</th>
<th>Functional Requirements</th>
<th>Non-Functional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>Ui</td>
<td>Xi</td>
</tr>
<tr>
<td>HInT</td>
<td>46</td>
<td>22</td>
</tr>
<tr>
<td>NFRs grade</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Manual</td>
<td>204</td>
<td>145</td>
</tr>
<tr>
<td>RCT</td>
<td>317</td>
<td>68</td>
</tr>
</tbody>
</table>

As shown in Table 2, we did not extract any words for TypeF from the minutes with the RCT. When we evaluated the results from the logrank test, a small number of sentences were classified by the RCT; they are, TypeRu, TypeR, and TypeP, which were not expected to give us trustworthy results. We analyzed the factors that affect the differences between the results produced by the two groups: one group used a manual operation and the other group applied the RCT.
3.3 Comparison of the Results

The purpose of the classification rules is to observe the process of requirements elicitation with categories. We observed the requirements maturation process in the case of using the $RMR(t)$ in formula (1). Observation time, $t$, was determined by the data of ten meetings from October to December in 2007. To valuate the classification rules and the RCT, we got two sets of results from the observation. One was obtained by a domain expert’s manual operation, and the other was obtained automatically by using the RCT. The results were compared and evaluated with regard to their similarity with the logrank test. The null hypothesis of the test is as follows.

$H_0$: The results produced by the two groups were not identical: one group used a manual operation and the other group applied the RCT.

The logrank test is applied at the 5% significant level. In other words, if $\chi^2$, as the result of the logrank test, is less than 3.8415 that is the number of the critical chi-square value with one degree of freedom, we can reject the null hypothesis. The results are shown in Figure 2. We can reject the null hypothesis for each type, except for TypeCtl which is a category related to the requirements of behaviors or scenarios of the system. We could not determine words that represent those requirements. The words related to TypeCtl were verbs appearing in the minutes, since verbs were used to explain the system's behavior and/or scenarios. The RCT was able to detect verbs. However, the verbs heavily depend on the context of the minutes. For example, the verb "send" was used to describe requirements on the e-mail management functions of the HInT. "Send" was also used in sentences to ask something in the stakeholders' communications. Thus, verbs are too vague for the members who joined the Delphi session to assign to TypeCtl. The context of the minutes may solve the verbs' ambiguities. Since the domain expert who analyzed the minutes by a manual operation seemed to be able to assign sentences adequately to TypeCtl, there may be a limitation of the classification rules. However, other types show that the rules worked well.

3.4 Strengths and Weaknesses

The RCT helped us improve the cost of analysis work from a week to minutes. However, before the analysis, the RCT needs the classification rules. The task of mapping words to the categories takes hours or a day. We took four hours in the Delphi session with six participants. Even though we take into account such costs, the RCT still gives us high productivity.

To develop the classification rules, six engineers and researchers joined a Delphi method session. During the session, we realized that it was hard for several engineers to distinguish between some of the categories. For example, some of them confused TypeUi with TypeU. TypeUi belongs to functional requirements and is a physical requirement of user interfaces. In contrast, TypeU is a requirement on the characteristics of usage. Within our project team, we had a lot of discussion on distinguishing these categories in order to build a consensus among us.

Before we applied the RCT, we assumed that the number of sentences classified by using the RCT would be greater than the number of sentences classified through manual operation because the tool was thought not to eliminate the noise caused by the ambiguity of words. However, the results were contrary to our expectation. The domain expert understood the minutes with their context and counted all possible requirements categories. This "deep understanding" might cause noise. The RCT was developed with the aim of achieving simplicity and productivity in and of analysis processes. Its simplicity worked well to eliminate noises from the minutes consisting of natural language. If we can provide the writing convention, the productivity of developing the classification rules will be improved.

As we mentioned in the first section, our goal is to manage requirements elicitation processes. The goal will not be achieved only by means of the RCT. A manager has to plan the elicitation processes for each of the categories and monitor them. If he/she finds trouble or a delay of elicitation, they must correct the elicitation processes by communicating with their customers and/or project members. The RCT was developed as a prototype tool. To help project managers find delays in and of elicitation, we are going to upgrade the RCT with the ability to visualize quantitative elicitation situations at various times as the project progresses. One of the problems is that we cannot refer to the domain specific classification rules during the progress of the project. In other words, we cannot observe the elicitation process of functional requirements. To solve this problem, the RCT should support incremental development of the classification rules. Another
problem is that, as shown in Figure 2, the elicitation processes are represented by RTR(t). \( RTR(t) \) is calculated by the cumulative number of requirements at the end of the project. Therefore, we cannot calculate them until the end of the project. The number that we can know at a certain time is the number of requirements elicited until the time of the project. We are now developing the next version of the RCT in order to represent the real-time situation of the requirements elicitation with the actual value of the number of requirements and to estimate the time necessary for the requirements to mature.

Figure 2. Comparison between the results on manual and the RCT
(The result of the chi-square test is shown in the parenthesis. If it is less than critical chi-square value, \( \chi^2_{cv} \), we can reject the null hypothesis, \( H_0 \). \( \chi^2_{cv} \) with one degree of freedom is 3.8415.)
4. CONCLUSION

In this paper, we defined the classification rules of requirements. A rule consists of a word in a requirement and within a requirements category. The RCT was developed to improve the observation process with the classification rules and the morphological analysis. The results were analyzed with logrank analysis, which proved the effectiveness of the classification rules.

ACKNOWLEDGEMENT

This work was supported by the Joint Forum for Strategic Software Research (SSR) in 2012. The authors would like to thank all the members and people who helped in this project. In particular, the authors wish to thank Prof. Noriko Hanakawa and Mr. Masaki Obana of Hannan University for kindly providing us the requirements data. We also thank Prof. Haruhiko Kaiya for providing us with the tool concepts and prototyping.

REFERENCES

A CASE STUDY OF A LARGE EUROPEAN FOOD RETAILER

Marius Janson, Emeritus Professor
University of Missouri-St. Louis. One University Drive, St. Louis, MO 63121, USA

ABSTRACT
Many organizations implement commercial Groupware packages into an already existing corporate culture and thus face the need of having to make considerable operational adjustments. This case study describes a unique instance where a retailing firm implemented an in-house designed Groupware to respond to an already existing operating philosophy. Retailing companies have to maintain positive relationships between the firm and the buying public, the firm and its employees, the firm and the unions, and between the employees and the unions. The quality, efficiency, and effectiveness of these relationships depend on channels of communication between the four parties. Based on a twenty-year long field study of a European food retailer we demonstrate how the in-house designed enterprise Groupware not only supported collaborative work among employees but also successfully managed all the above relationships.

KEYWORDS
Groupware, Implementation, Information Systems, Employees, Unions.

1. INTRODUCTION
Groupware comprises email, electronic conferencing, discussion forums, collaborative writing, document handling, and customization of databases. Modern organization often create teams drawn from staff attached to different departments and based in different geographic locations. The advantages gained from bringing these individuals together to share ideas, solve problems, and annotate are some of the significant arguments for adopting Groupware (Aldenberg et al, 1999; Jones, 2005; Lou et al, 2006; Rifkin, 1995).

Successfully implementing Groupware, however, often requires major organizational adjustment. Orlikowski’s (1992), for example, describing the introduction of Lotus Notes in Alpha, the case company, argues that successful user organizations need to move away from a competitive culture toward a reward system that stresses group results. Her analysis revealed that Alpha’s senior management gave little thought to introducing Lotus Notes. Staff members did not receive training or instructions how to work with this Groupware package. Instead personnel were expected to learn to use the software system on their own which they refused to do. Orlikowski (1992) suggests that organizations which build a collective capability in distributed organizing will be successful. This calls for networked organizations that use more lateral than vertical communication.

This case study reports successful design, implementation, and operation of an in-house developed Groupware package by the Colruyt Company, a large Belgian food discount retailer with annual revenues of US $6.8 billion. In 1965 the firm opened its first discount food outlet. It developed an organizational culture that emphasized devolution of power, decision making, and the acceptance of responsibility by individuals at all managerial levels.

The Company’s organizational culture stresses interpersonal communication which it regards essential to collaborative work processes. Given these conditions it was a natural step for the Company to consider using software to support individuals in their daily work assignments. Introducing an in-house developed Groupware package was a great success. However, Groupware introduction was one of the reasons of a clash with the Unions who in turn used a nation-wide TV broadcast and published a case study to make their displeasure known to the buying public. These actions seriously damaged the firm financially and its brand recognition with the clients. The Groupware package became successful only after the Company opened effective lines of communication with the Unions and its customers.
2. THE COMPANY

The Company opened its first discount food outlet in 1965. The firm developed an organizational culture that emphasized devolution of power, decision-making, and the acceptance of responsibility by individuals at all managerial levels. The Company’s organizational culture always stressed interpersonal communication which it regards essential to collaborative work processes.

IS development was an ongoing program of organizational development and improvement. Jo Colruyt (Former CEO, Interview 1993) established a user-initiated and user-driven process for IS development. Contrary to the situation at many organizations, Jo Colruyt preferred to informatize in the interest of worker ability to do the job well. He saw workers as custodians of knowledge essential to corporate development which had an all-pervasive effect on how the company involves the user in information system development.

Based on our interviews over a twenty-year period with more than twenty-five employees ranging from store clerks to top management and on attending many company meetings we conclude that Colruyt employees are indeed taken seriously. We observed that Colruyt employees have a need, are willing, and have the ability to make decisions and to meaningfully participate in decision-making (Colruyt, Interview 1993). We found it remarkable that during the many meetings we attended every participant was accorded time to make his/her contribution. Each expressed his/her opinions, yet opposing views did not cause meetings to get bogged down and go on endlessly. Before the development and installation of the Groupware meeting summaries were telephoned to and then typed by members of the typing pool and subsequently sent by company mail to the workers.

During the many meetings which we attended we observed that Colruyt employees have the need, are willing, and have the ability to make decisions and to meaningfully participate in decision-making. We regarded it remarkable that during the many meetings we attended every participant was accorded time to make his/her contribution. Each expressed his/her opinion, yet opposing views did not cause meetings to get bogged down or go on endlessly. Before the development and installation of ISID meeting summaries were telephoned to and then typed by members of the typing pool. Next these documents were sent by Company mail to the recipients.

Likewise, after a meeting between company management and representatives of the Unions the employees would receive a written copy from management about the meeting’s outcome. Similarly, the workers would receive a written copy of the Union’s position sent through the regular mail. Therefore, the workers were informed by members of top management and Union representatives at approximately the same time. With the introduction of the Groupware package management sent its version of the meeting’s outcome to the workers electronically. Therefore, workers would always learn management’s position concerning important issues first and receive the views of the Unions later. As will be discussed later this fact would become the source of a significant disagreement between Company management and Unions.

2.1 A Story of ISID Development

Organizing work and decision-making by affected employees led to a need for efficient and effective communication. The idea for an interactive system for information dissemination (ISID) came about during the end of the 1970s. It was revolutionary at the time to use a software system to store and disseminate documents and memos:

“At that time IBM had a software editor (TSO) that supported communication between mainframe users. [It] was the essence of my idea – that we could transfer information using existing software. We used this IBM software as the core of our system [for storing information], which we implemented gradually throughout the Company.” (Former CIO, Interview 2000)

By the mid 1990s ISIDs capabilities were quite limited. It performed basic functions such as creating, storing, sending, and printing documents using a network of approximately six hundred terminals connected to the mainframe computer located in Company headquarters. ISID comprised three mainframe computer files: a Glossary file (keywords and memo numbers), a Text file (text and memo numbers), and a Title file (keywords and memo numbers).

ISID’s success was the result of Company managerial practice. Since its inception the Company had engaged professionals in organizational development and application of behavioural theories such as sensitivity and assertiveness training, as well as training in communication skills. Jo Colruyt held employee
training essential to good management and corporate success. First Company management partook in the training and then large numbers of employees attended various behavioural training programs:

“Workers at the lowest level were grouped with others who belonged to the entire range of hierarchical levels in the company. It meant that Jo Colruyt participated … right along with a worker in charge of picking products in the warehouse. Naturally this resulted in a total revolution concerning the relationship between management and workers. Accordingly, this resulted in a very special organizational culture.” (Former CIO, Interview 2000)

“Corporate culture aimed at developing individuals in step with the growing company. People actually enjoyed working for Colruyt. Being employed by Colruyt meant taking some risk because especially in the 1980’s the business environment was very bad.” (Former CFO, interview 2010)

“I attended T-Group meetings where I learned to better know myself. I took classes in Gestalt and assertiveness training. These courses formed the basis for my personal development.” (Worker, 1985)

ISID development was intimately embedded in emerging forms of cooperative working (including meetings) and employee participation in decision-making. New forms of working and decision-making depended on ISID and at the same time provided impetus for its further development. ISID development was seen as ‘totally integrated with the way things are done here’ (Former Manager of Marketing, Interview 1993). Constant Company development produced continuously emerging expectations and raising demands from users. The more ISID was used the more users realized its potential and the higher were their expectations and demands for new features.

ISID development continued motivated by demands for effective communication and information sharing. Pressures to expand the Groupware and develop new functions came from various quarters. On the one hand there was a visionary leader Jo Colruyt, then CEO with ‘a personal belief in the possibility of IT’ for enhancing not only business processes (e.g., purchasing, distribution, sales, marketing, promotion) but on the other hand company communication and cooperative forms of work. ISID enabled top management to stay abreast of business developments:

“Jo [Colruyt] strongly supported ISID’s development. He ordered that anything communicated be it by phone or writing; also be recorded. [He could stay abreast] of what happened, he could intervene or say ‘I am not in agreement with this or that because it goes against Company philosophy.” (Former CFO, Interview, 2010)

Many employees were enthusiastic about being informed about the Company and by ISID’s development as illustrated by this employee:

“[ISID is] a fantastic system for storing information and for communication [was] built because the Company considers it imperative that everyone becomes informed to a degree necessary to do his/her job … The Colruyt Company has its unique atmosphere that is not limited to form – there is content as well. For me the unique aspect was the extensive and wide-ranging use of information technology and a simplified bureaucracy. Every document is accessible in a short time, everything proceeds speedily and effectively.” (Member Workgroup, Interview, 1985)

“[When you verbalize something] you can create miscommunication because the listener understands something entirely different from what you intended. If you write you have to ask yourself ‘is this really what I want to state?’ Many individuals [can access] this information [because it is stored in ISID. That is the advantage of written communication. Jo Colruyt strongly promoted … by encouraging his employees to turn all communication into written form: phone conversations, notes between people, conversations in the hallways.” (Former CFO, Interview 2010)

“ISID is the materialization of Colruyt’s basic principle concerning information: employees independent of hierarchical levels should have access to information they consider needed to perform their tasks as well as possible.” (Jo Colruyt, Interview 1993)

These quotes illustrate reasons for using ISID, namely, enabling clarity of information, creating a democratic work place, participating in workgroup problem-solving efforts, overcoming hierarchical organizational structures, and enabling directors and others to stay informed about corporate activities.

2.2 The Crisis with Unions

Figure 1 reflects the communicative relationships between Company, Employees, Clients, and Unions in an ISID environment. First, Colruyt and employees shared written and ISID-supported electronic
communication channel. Second, Colruyt and clients shared a limited written communication channel in the form of in-store or mailed announcements. Third, between clients and Unions existed a limited written communication channel in the form of, for example, newspaper reports. Fourth, the Unions and employees shared a limited written communication channel taking the form of documents sent by regular mail. Fifth, employees and clients participated in face-to-face communication. Finally, between Colruyt and Unions there was two-way face-to-face exchange, written and a Company-to-Unions one-way ISID-supported communication.

![Figure 1. Communication among Parties](image)

By the mid 1980s the company employed approximately 1,500 persons. In Colruyt there existed an atmosphere of trust because of great openness concerning the release of information that creates and maintains trust’ (Former CIO, interview 2000, Former CFO interview 2010). Starting from early 1970s employee relationship with the Company had changed in accordance with Jo Colruyt’s managerial philosophy and Company growth. Company change and worker identification also arose from management and employees attending identical seminars:

“Identification with the Company as long as it (Company) is willing to change. The Company has to change its orientation … when many individuals attend seminars. That Company cannot maintain the same philosophy … it becomes a different organization.” (Jo Colruyt, former CEO, Interview 1993)

The Company’s participative work environment did not sit well with the unions. They felt that the organization’s participative character meant workers were constantly pressed to find ways of working so as to increase efficiency. There was little love lost between the Company and the Unions:

“[The Company] has to maintain tight control over informing the workers. Of course the unions have a right to exist, but they should not get exclusivity as to informing workers. If that happens [we would] be lost. This happened in the steel industry – the CEO and union delegates felt superior to the workingman. This led to the workingman being informed by the union only. Of course that is catastrophic. Therefore, I instructed the [HR] director not to forget that he negotiates [with the union] on behalf of 5,000 Colruyt employees. The union negotiators should not be able to absorb our [HR] director in their little clique. The current [HR] director does an excellent job and communicates directly with our workers concerning the negotiations with the unions.”Jo Colruyt, former CEO, Interview 1993).

The efficiency and effectiveness of ISID with which to inform workers helped to build trust among workers and management and was seen as assisting the development of that relationship. ISID was not perceived by the Unions in a positive light:

“The Unions could no longer … be the gatekeepers of information which came from the workers and went to top management and vice versa. We in the firm thought the unions should stay out of it and ISID
provided support for communication and enabled a [direct] relation between management and workers. For this reason at a certain moment [1984] the socialist union published a book about [what it believed to be] several worker problems and inequities.” (Former CIO, Interview, 2000)

The Unions, in response to these misgivings, published the book ‘Dossier Colruyt’ (Adele, et. al., 1984). The publication described in explicit detail what, according to the Union, were concerns with the Company. Furthermore, the Union also participated in a TV program where the so called concerns were nation-wide ventilated. The book’s publication was a serious blow to the Company in that its name was besmirched in the eyes of the buying public which in turn led to a significant drop in sales revenues.

The clash with the Unions occurred during the early 1980s when the iron curtain still existed together with the Soviet Union and East Germany. During that period the socialist union in Belgium was still under the influence of Communist, Leninist, and Anarchist philosophies. In fact during that time there existed in Belgium an influential group named ‘All Power to the Workers.’ The publication of the anti-Company book and its content reflected to some extent the philosophy of the period (Former CFO, Interview, 2010)

The Union’s book used information illegally drawn from ISID by several Union representatives:

“They [unions] used information from ISID that they had acquired with the help of a radical union steward [who was a company employee and thus had ISID access] to start a campaign of misinformation. They [union] shifted commas and periods, left out various words and sentences in such a way that [ISID] documents took on a different meaning.” (Former CIO, interview, 2000)

The reactions among the workers were mixed with some requesting the perpetrators be sacked and others arguing for strict control of access to information. However, the former CIO recalls, Jo Colruyt was against repressive measures. He was also not in favour of controlling access to ISID either. Instead he said ‘we should educate workers to use information responsibly instead of making information inaccessible’. After a public debate a clause was included in each employment contract:

“The employer provides each employee with an extensive system for communication that is based on the daily exchange of confidential or not so confidential memoranda. Any release of information external to the Company is forbidden and amounts to breaking the work contract.” (Jo Colruyt, Former CEO, Interview 1993)

But the event made obvious that completely open employee access to ISID created too high a risk for the Company that could not be justified. As a result access to highly confidential information in ISID was restricted. Currently:

“70% of ISID documents are not confidential and 30% are confidential. Anyone in the company has access to non-confidential ISID documents whether he was listed a recipient or not. 20% are confidential ISID documents can only be read in their entirety by recipients and non-recipients can only read the keywords [and with special permission the whole document]. The remaining 10% are accessible to recipients only.” (Former Manager of Marketing, Interview, 2003)

Presently, however, relations between Unions, Union stewards, and the Company are much improved. In fact, a Union steward responded as follows:

“I have many years of experience as a Union representative with the Company. I think I earned the respect of management as a Union steward because of my positive orientation … I also plan the Union’s website and compose the Union’s newspaper. I am presently very active nationally as a Union representative.” (Union steward, Interview, 2010)

This and several other incidents of ISID misuse prompted discussions on the appropriate use of information and contributed to the development of not only new features of the system but also new norms and rules governing the system’s use.

3. RESOLVING THE CONFLICT

Figure 1 illustrates the necessary steps for conflict resolution without compromising any ISID features. In the interest of the Company three communication streams of Figure 1 need to change. First, communication between the Company and employees is enriched by electronic means using ISID. Second, the limited written communication channel between the Company and clients were enhanced by ISID-supported targeted electronic advertising, and online-shopping. Furthermore, the Company has modified the content of its interaction with the Unions from adversarial to conciliatory:
“The Company refrains today from the in-your-face confrontation and plays the role of the ‘conciliator.’”
(Union Representative, Interview, 2010)

In the interest of the Unions two communication streams of Figure 1 can be modified. First, the Unions are prohibited to use Company email addresses to contact employees. To overcome this limitation, the Unions can suggest employees acquire private email accounts. This would speed up communication between Unions and employees and enable informing the workers about important issues in a timely fashion. The Company has indeed implemented above three suggestions. The actions the Unions have taken to improve communication between employees are as yet unknown.

![Diagram of Colruyt Mission](image)

Figure 2. Company’s Mission (Derived from Colruyt Annual Report)

Figure 2 shows the Company’s broad set of actions taken to improve its image vis-à-vis the parties in its complex business environment. First, every business decision is balanced by concerns for its economic effect and impact on the ecological and social environment. Second, the Company established an ongoing strategy of continuously informing customers, employees, and stakeholders. The Company has to a significant degree improved its relations with the Unions. For example, an interesting example of combining concerns for the workers and the ecological environment is the firm’s bicycle program:

“The ‘mobility policy’ means the Company bought a bike for each employee who wanted one. The Company established a covered building next to the local train station for storing the bikes. The purpose of the policy was to enable workers to use the train to come to the railroad station and then use the bike to travel to the workplace. This policy is deeply appreciated by the workers.” (Union Representative, Interview 2010).

The Company/worker collaboration is just one of the many actions taken to improve relationship between customers, workers and the Unions. For example, in keeping with concerns for ecology the company is presently energy independent. This has been achieved by installing windmills and sun panels for electrically powering warehouses and retail outlets.

Our findings support the advice of Orlikowski who stated that successfully introducing Groupware needs worker education and a collaborative work environment. However, in the case of the Colruyt Company the successful ISID introduction also required the Company changed its relationships with employees, customers, and stakeholders. Indeed a much more incisive change.

4. CONCLUSION

This paper demonstrates the far-reaching consequences resulting from an innocuous appearing implementation of a Groupware package. These consequences affected relationships that went far beyond the Company and included relationships between the company and its employees, clients, and unions in essential
ways that ultimately led to a serious set of negative consequences. These consequences could be resolved only with the Company’s willingness to totally rethink its approach to the use of its Groupware and the business.

REFERENCES

THE SPECIFICITY OF SOFTWARE FOR DISTRIBUTED ORGANIZATIONS – THE PROPOSAL OF AN ENTERPRISE MODEL

Jędrzej Wieczorkowski and Przemysław Polak
Warsaw School Of Economics - Al. Niepodległości 162, 02-554 Warsaw, Poland

ABSTRACT
The article discusses the issues of information systems designed for large multidivisional and distributed organizations, including transnational corporations. The authors described a business model and a data structure specific to the distributed organizations. The models take into account both, the point of view of enterprise information systems, including ERP systems, i.e. transaction processing systems, and the viewpoint of analytical software or business intelligence systems.

KEYWORDS
Information systems, enterprise information systems, ERP systems, analytical systems, corporate data warehouse, distributed organizations.

1. COMPLEX ORGANIZATIONAL STRUCTURES AND THEIR INFORMATION REQUIREMENTS

In recent years, the globalization trend could have been observed in the world economy. During that period, mostly through mergers and acquisitions, transnational corporations have become increasingly important in many sectors of the economy (Hitt et al. 2011). The ownership changes entail changes in management methods and, consequently, the changes of intra-corporate information flows. The boards of independent companies often have different investment preferences than the corporate owner for which it is very important to have all necessary information about all plants in a reasonable time. The easiest way to achieve this goal is through the implementation of an information system that is standard solution across the whole corporation.

Complex business organizations can have two basic forms (Taylor 1996):
- divisional corporates,
- holding companies.

The divisional corporate (multi-plant enterprise) is a simpler structure within a single legal entity. The criterion to separate companies does not result form the legal requirements, but reflects the geographical location. Each plant can have its own management, may have separate assets and funds, however, this is only relevant internally – for managerial purposes. External reporting (e.g. financial statements) applies to the whole organization, and a balance sheet is created on this level.

Holdings are the structures of interrelated companies. These companies are separate entities from the legal point of view. In the case of trans-national capital groups, they operate under different local jurisdictions – the states in which they are registered. In the holding, there is always a parent company and its subsidiaries.

According to Gmytrasiewicz and Karmańska (1998), based on the observation of global practices, three main types of capital groups can be distinguished:
- consortia,
- conglomerates,
- investment groups, created by financial institutions incl. banks.
A consortium operates in a single economic sector, combining companies that perform related activities or perform the series of the phases of a single production process or a supply chain. The consortia are created in order to control the larger part of a sector by coordinating their actions.

The conglomerates combine companies operating in the different industries. They arise from investing financial activities aimed at increasing the efficiency of capital utilization.

Modus operandi similar to the conglomerates characterizes investment groups centered around the capital of financial institutions. However, in the case of institutions, for which investment activities are the core of business, an investment time horizon may be shorter than that of the parent company in the conglomerates. In practice, the complex economic structures can have features of the various types of capital groups, for example a consortium including multi-plant companies.

The type of the organizational structure largely determines the necessary features of the information system. These systems should meet two main categories of information needs:

- internal – used for managing corporation,
- external – reporting as required by law.

Managing a consortium requires harmonizing the actions of all individual companies, for example, in planning the size and schedule of production, controlling the execution of plans, and coordinating prices. In the case of a conglomerate, internal information needs focus more closely on the examination of the effectiveness of capital investments.

The type of relations between companies plays also a very important role in external reporting. For example, the most important factor is whether the individual divisions are self-balancing companies. In such case, the law requires the reporting to be done on at least two levels: elementary for each company and consolidated for the whole group (Romanowska et al. 2000).

In many cases, the authors observed in the complex business structures the duplication of the organizational units particularly those involved in finance, procurement, distribution and human resources management. These units often do not cooperate with each other to the desired degree. They can use different accounting and budgeting procedures. Therefore, the implementation of corporate standards, the modernization of an organizational structure and the implementation of optimized and standardized business processes supported by the use of appropriate information technologies can lead to reduced costs and improved efficiency across the corporation. For this purpose, the implementation is carried out with the usage of the method of roll-outs. In such cases however, the specificities of individual markets and the adaptability of the proposed solutions to local requirements should be taken into account. This is due to legal circumstances (e.g. rules for the calculation of taxes) and the cultural environment.

In practice, the corporate implementations, as part of their practices, often require separation of the core processes used in all subimplementations and additional local extensions. It is necessary to maintain a balance between standardization and diversity. On the one hand, care must be taken to preserve the best of local business ideas. On the other hand, the integrity of a system must be maintained and, in many cases, the best local practices can be considered for implementation in other local divisions. The various issues of the implementations in corporations were discussed, inter alia, by Ghosh (2000), Ray (2011), Harwood (2003), as well as, concentrating on the cases in Poland, by Cypriański and Stelmach (2003), Stepniak and Turek (2007).

Most of the considerations mentioned above apply to distributed organizations operating in the traditional form. In the case of institutions operating according to the concept of co-operative economy, e-marketplaces and virtual organizations, their information needs and, consequently, their computer systems differ considerably. Special interorganizational integration solutions are used which are a separate topic and are not discussed in this paper. Further reflections on the architecture of corporate systems and enterprise models apply to the traditional model of distributed organizations. The purpose of this article is to describe a business model and a data structure specific to the distributed organizations proposed by the authors. In particular, the authors conducted the analysis of organizations which have the structure of a consortium. Such enterprises are characterized by the extensive requirements for transaction systems.
2. THE ARCHITECTURE OF INFORMATION SYSTEMS IN DISTRIBUTED ORGANIZATION

In complex corporations may occur a situation in which every division uses a different transactional system supporting its business processes. In such cases, it is necessary to use separate software to consolidate data for managerial purposes on the corporate level and to provide suitable tools for external reporting. In the case when every local system is developed independently, maintaining software, including the consolidation system, is very complicated and expensive due to the necessity of continuous remodelling interfaces with multiple different divisional systems. In such a situation, it is also difficult to maintain the appropriate quality of data in the consolidation system. A similar problem occurs when exporting data to separate analytical systems.

The problem of the data quality causes common efforts to define uniform information standards in corporations. Such standards help to ensure the implementation of the corporate governance, which draws particular attention in recent years. It involves, among other things, harmonizing reporting results for analysts, supervisory bodies and external recipients. It also entails the adoption of a single corporate architecture, defined as the formal description of the structure and function of corporate components, interrelationships between these components and the principles and guidelines governing their creation and development in time (Szafrański and Sobczak 2009). Particularly important are the architectural principles of the basic assumptions for the design of information systems. The article concentrates on a solution based on an integrated transactional information system. Usually such role is played by an ERP-class software package provided by a chosen vendor.

The authors distinguished three main architectures of corporate information systems. The classification was based on integrated transaction processing systems implemented in the enterprises with a complex structure:

- individual local systems,
- a centralized data processing center with local software installations,
- a centralized data processing center with a central software installation.

The architecture of the individual local systems is based on the concept of independent divisional installations in distributed locations supplemented with additional tools for the data consolidation. This solution leaves the administration of the system to individual plants. The implementation of such a distributed system in the multi-division corporation usually is carried out with the pilot conversion method and the roll-out. This solution also requires the use of tools that provide data download from local installations and create consolidated information. In this architecture, the transaction systems do not require any specialized data structures mapping complex corporate structures as a single installation usually stores data related only to one division, whereas the consolidation system is an independent piece of software. In a case when a division needs to have access to some general corporate data, the mechanism of data replication must be implemented.

The architecture of the centralized data processing center with the local software installations involves installing independent systems for each division and additional tools for consolidating data in one (or in a few) corporate data processing centers. The logical view of this architecture is, in this case, very similar to the architecture of individual local systems. The difference is that no physical installations are made in individual divisions, they are made in one or a few data processing centers. In case of large global corporations these data centers usually serve the group of countries or a continent. The structure of these centers can take into account the existence of different time zones and working hours in them, designing locations so that at any time at least one center has standard business hours. Whereas, the installations or at least the data areas remain dedicated to individual divisions. Hence, the issues of the data structures and the consolidation are similar to the case of the architecture of individual local systems. Therefore, the usage of the centralized data processing center with the local software installations facilitates the administration of the system and causes the reduction of costs.

The architecture of the centralized data processing center with the central software installation is based on a single information system with a single data area for the whole corporation. This solution is the most demanding and requires:

- ensuring the adequate system performance and data transmission,
- applying solutions allowing the necessary customization for individual divisions,
ensuring organizational procedures for managing a very complex system.

The systems based on the centralized data processing centers with the central software installations require specific data structures which are discussed in the further part of this article.

3. THE MODEL OF THE ORGANIZATIONAL STRUCTURE FOR THE TRANSACTION PROCESSING SOFTWARE

The centralized system used in a distributed organization requires special software mechanisms to handle the multi-company enterprise. These mechanisms are designed to ensure, on the one hand, the coherence of the system as a whole, on the other hand, they enable some level of the individualization of systems in different divisions. This individualization is due to the specific nature of the activities of individual divisions and the conditions of operations in different markets – in the different economic and legal systems of various countries.

Large, top class integrated information systems, classified as ERP/ERPII systems, usually contain functions designed for such organizations – multinational corporations. The most important element in terms of the system customization to the needs of distributed organizations is the ability to define in the system the extended structure of the enterprise. It is the basis for the usage in the individual organizational units different data dictionaries derived from a common corporate database. It also allows to use the different variants or versions of applications, for example, different processing procedures and implemented business processes, as well as various reports and screen forms.

The most convenient way to analyze the structure of an enterprise implemented in an information system is to treat it as a model which includes object classes corresponding to the real formal objects in the corporation and logical object classes, distinguished only for the purpose of the system implementation. The article presents the original model of the structure of an enterprise developed by the authors, based on the actual solutions used in the ERP systems. In the leading systems, these solutions are very similar, although there are some differences in details and in terminology. Because systems provided by SAP seem to be the most comprehensive and very popular, the authors based the naming convention and some specific concepts on these solutions (AC040... 2001, AC200... 2009, http://help.sap.com). In order to reduce the complexity of the model, the authors partially limited its scope, focusing on the structures associated with the financial modules of integrated information systems.

Four basic object classes were distinguished in the model (see Figure 1):
- a corporation (capital group),
- the chart of accounts,
- a company,
- a plant.

![Figure 1. General relationships between object classes in the model of the structure of an enterprise.](image)
In terms of financial accounting, a basic entity in the organizational structure of an enterprise (a corporation) is a company – a unit distinguished from the point of view of the business and tax law. The company should be treated as a self-balancing entity.

A company can contain multiple plants. The plant does not have to be separated from the legal point of view. Its existence is caused by its isolated location. It is separated mainly for the requirements of logistics modules (for example: materials management and production planning).

Every company works according to the specific chart of accounts. The unification of the charts in different companies simplifies financial reporting. In this case, the chart of accounts has a broad meaning covering both synthetic ledger accounts and analytical records containing, for example, the accounts of partners.

In the case when many companies from a single corporation are located in one legal area (for example in one country), it is likely that they use identical or at least similar charts of accounts. Therefore, the information system should allow to define the chart of accounts at a higher level than the company, so that each individual company could be assigned to one of the defined charts. In this case, defining specific synthetic accounts should take place at two levels: the chart of accounts and the settings specific to each company.

International corporations usually use the variety of the charts of accounts. This is due to legal requirements or accounting traditions in different countries. If individual companies can not, or, because of some objective reasons, do not want to use the common corporate chart of accounts the information system should support the usage of the parallel charts of accounts in a single company. For example, beside the national chart of accounts, the chart of the capital group may be used, and one of them acts as the operational chart of accounts. It should be noted that this approach does not fully solve the problem of differences in the rules for the purposes of corporate accounting and external reporting, as it requires the clear allocation of accounts from the national chart and the chart of the capital group. In practice, it is often not feasible because of large differences in the accounting standards. In this case, it is possible to apply a solution involving defining all accounts in one chart and then to configure the reports to receive data arranged in accordance to one selected accounting standard. However, it involves the increase in the number of accounting records and in the complexity of assigning records from documents to specific accounts.

Another situation occurs when defining business partners in the system. In the majority of ERP systems detailed information on transactions with individual partners are not stored directly in the ledger, but in the sub-ledgers. They serve as an analytical register. In the general ledger, accounts are synthetic, where the transactions recorded in the sub-ledgers are also stored.

Typically, in the standard integrated information systems, two separate account books are kept for vendors and for customers. However, in complex corporations, individual suppliers and customers can cooperate with the companies that use the different charts of accounts. Therefore, in order to group information about settlements with individual partners on the level of the corporation, the software can offer a function allowing to define suppliers and customers in two segments: corporate (the whole system) and the company. For each customer, the general data (e.g. address) can be defined in the corporate segment, whereas, the specific data for the company (for example: the default payment terms in relations with the partner) in the company segment. The different structure of segments than that used in the general ledger results from the frequent lack of local legal regulations concerning the method of conducting the analytical register of transactions with partners. In the integrated information systems, it is also possible to define other structures to which the partners are assigned, for example, associated with the limits of debts, supply areas, or sales areas. Such structures may be flat (for the whole corporation) or multilevel.

Regardless of the division into the companies, the corporation can be divided into the areas of activities carried out by the corporation. These areas are called business areas. They can be related to general industries, or to some specific business segments covered by the activities of the corporation. They can carry out alternative reporting, independent of the formal structure of the corporation. The business area can contain multiple companies, but the company can also perform its activities within many different business areas.

Various ERP systems treat differently the analysis of costs and revenues. It is usually done outside the general ledger in the specialized controlling module of an integrated system. The controlling uses new object classes in the enterprise model, in addition to, described above, the objects relevant to the financial accounting. For example, the organizational structure of a company in the controlling module may include
objects described previously (i.e. the company, the plant, the business area and the chart of accounts), as well as such object classes as a controlling area and an operating concern.

The controlling area is an object in which costs and revenues, together with their clearing, are managed. The controlling may extend beyond the company, because one controlling area can include multiple companies. Every company is associated only with one controlling area. It is necessary that in the whole controlling area and, consequently, in all its companies, the same operational chart of accounts is used.

The operating concern is the superior object to the controlling area. It is used for the summary analysis during the consolidation of corporate data and it reflects the structure of corporate market segments. Every controlling area belongs to one operating concern, whereas the operating concern can contain many controlling areas. In most cases, corporations use only one operating concern. The structure of an enterprise, taking into account the objects related to the controlling is shown in Figure 2.

![Diagram of enterprise structure](image)

Figure 2. The simplified model of the selected objects of the enterprise structure, taking into account the objects used by the controlling (in accordance with the ERD notation).

The main reason for modeling the structure of a multi-company enterprise in information systems is to facilitate the consolidation of data from different companies, plants and the other units of a corporation. Properly conducted the consolidation of financial data usually requires to meet the conditions of the comparability of data. These conditions must be identified and met during the configuration of the system in the implementation phase. For example, it is necessary to ensure the uniformity of corporate accounting periods and the proper configuration of these periods in the system. The modern ERP systems should also support the usage of multiple currencies.

The primary consolidated financial statement is the balance of a company together with required attachments. The system should allow to define multiple structures for the balance sheet, suitable for the various shapes of required reports. For example, these reports may be required by the law of specific countries or may have the form following the standards applying different valuation criteria such as IAS/IFRS (International Accounting Standards/International Financial Reporting Standards) and US-GAAP (US – Generally Accepted Accounting Principles).

4. THE ARCHITECTURE OF THE ANALYTICAL SYSTEMS AND THE CORPORATE DATA WAREHOUSE

The solutions presented above are focused on integrated transaction processing systems, mainly ERP systems. The situation is different in the case of analytical information systems known also as business intelligence systems. In most cases, they are based on the concept of a data warehouse. Traditionally, taking into account the possibility of the separation of data according to the scope the company's activities, several architecture models of the data warehouse are distinguished such as: a central data warehouse, a data mart, as well as multi-layer models combining these solutions, including the architecture of common dimensions (Kimbal 2002, Inmon 2005, Todman 2001).
A multi-layered hierarchical architecture can be proposed from the point of view of the needs of distributed organizations. The basic allocation of layers is related to the structure of the divisions. The operational data, from the transactional information systems of individual divisions, are the data source for the lowest (divisional) layer. The data stored at this level are the most detailed. This layer is used for the analyses at the level of divisions, while being also the intermediate filter of data feeding higher layers. The layers in subsequent levels include data on the higher level of aggregation. The number of layers depends on the number of levels in the hierarchy of a corporation (e.g. divisions, regions, an entire corporation). The higher layer of the warehouse, the data contained in it cover a wider range (concerns more divisions) and the data have the higher level of generality.

The hierarchical architecture can be combined with the typical multi-layer architecture by separating in a single layer (e.g. a divisional layer) the sublayer of data marts in order to improve warehouse efficiency. The implementation of the data warehouse with the multi-layer hierarchical architecture in a large corporation is an extremely complex task, requiring the construction of a comprehensive data model having analytical significance for every level of a corporation. Such project is particularly justified in the absence of the centralized corporate transactional information system.

Figure 3. The structure of the multi-layer, hierarchical architecture of the data warehouse.

5. CONCLUSION

Typical differences between the operations performed in the online analytical processing using the data warehouse compared with the operations carried out by the online transaction processing systems (read-only data access, the need for one-time access to the large quantities of elementary data, the complexity of data processing) determine, according to the authors, the different trends in the centralization of transactional and analytical systems. In the case of the transactional systems for distributed organizations, particularly the ERP class systems, there are observed the trends of the centralization of processing and the strict integration of data. Consequently, specific data structures are used to enable support for large corporations. The proposal of the model of such structure was presented in the paper.

In the case of complex analytical business intelligence systems, it is avoided to construct the single-layer centralized corporate data warehouse that stores data in one area, and to base it on the general data model. This type of a uniform corporate decision support system, based on the single-layer data warehouse, would be exposed to very serious performance problems. Whereas, proposed in the paper, the multi-layer hierarchical corporate data warehouse can successfully operate as a system supporting analyzes both in the top corporate layer, as well as in the divisional layer.
REFERENCES


http://help.sap.com
VALUE ENCOUNTERS IN PLATFORM AS A SERVICE: INFORMING THE STUDY OF VALUE COCREATION

Andreas Nilsson1 and Johan Magnusson2
1Center for Service Science & Innovation, Stockholm University - DSV, Forum 100, SE-164 40 Kista, Sweden
2Centre for Business Solutions, University of Gothenburg - Box 100, S-405 30 Gothenburg, Sweden

ABSTRACT
During the past years, there has been a surge in research highlighting the need to address value creation from a cocreation perspective. In parallel with this, there has been an increased amount of research on service based delivery models for packaged software, linking the diffusion of new business models such as platform as a service (PaaS) to the literature surrounding platform strategies and multi-sided markets. Research focusing on the intersection of these aforementioned fields have so far but scraped the surface of understanding the role that platforms play in the cocreation of value for packaged software. This paper explores how the notion of value encounters can inform our understanding of value cocreation in PaaS ecosystems. This is operationalized through the case of an app store initiative in a Swedish Enterprise Resource Planning (ERP) vendor.

KEYWORDS
Cocreation, ERP Appstore, ERP ecosystem, Value Encounter

1. INTRODUCTION
With an increase in scholarly interest in service economies (Sarker et al, 2012), the notion of value cocreation has received ample attention during the last couple of years. As noted by Grover et al (2012), value cocreation constitutes a tenet of value creation, and is of paramount importance for the overall economy. Despite this, previous research has largely overlooked the creation of value between actors, where complementary resources are combined to create value (Sarker et al 2012). With an increase in various forms of interorganizational collaboration in parallel with an increase in business models focusing on services rather than products, a deepened understanding of value cocreation becomes critical (Grover et al, 2012; Sarker et al, 2012). In terms of methods for studying said value cocreation, Nilsson and Uppström (2012) propose the use of the Value Encounter Model (VEM), focusing on value cocreated through encounters between actors in an ecosystem.

In an answer to address this increased need for knowledge, researchers have addressed cocreation from a multitude of different angles. As a central area within the field of Information Systems, the study of packaged software (Sarker et al, 2012) constitutes a strong candidate for studying value cocreation. As previously noted by (Grower and Kohli, 2012), the market for packaged software such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) is representative of the aforementioned developments concerning interorganizational collaboration and new business models. From previously appending to traditional software license and value-added reseller models, (Weiner, 2012) notes that new business models are swiftly starting to dominate the market. Business models such as Cloud Service Brokerage (CSB), Software as a Service (SaaS) and Platform as a Service (PaaS) are more and more being perceived as the new dominant logic (Magnusson et al, 2012). In particularly the latter of these, PaaS, has been highlighted as the “new black” within ERP provisioning (Magnusson and Nilsson, 2013), combining a service transition with the adoption of platform strategies as defined by Gawer (2009).

Given this introduction to the problem area, the research question in focus for this paper is: How can a focus on value encounters inform the study of value cocreation in a PaaS ecosystem?
This paper takes a starting point in a research project directed towards aiding the design of an ERP app store. Following the app store initiative of a large, Swedish vendor of ERP systems, the research team conducted interviews with representatives from the entire ecosystem of vendor, customers and partner organizations.

This paper is organized accordingly: After a brief overview of the current state of affairs within related research (§2), the method (§3) and results (§4) are presented. This is followed by a discussion (§5) summarizing the main findings and discussing the implications, contributions and limitations of the study.

2. PREVIOUS RESEARCH

2.1 Value Encounters and the Cocreation of Value

In line with the two separate theoretical frames of reference for cocreation of value, RBV and SD logic, published attempts of modeling cocreation of value builds on either SD logic or Resource Based View (RBV). It is clear that the RBV perspective has a stronger validity within the Information Systems (IS) community as they are published in the highest rated publication forums. The use of SD logic as a theoretical lens to study cocreation still needs to gain more empirical validation in order to become a solid research discipline (Arnold, 2008; Weigland and Arachchige, 2009).

In the models attempting to capture and explain cocreation, there is an emphasis on an encounter-process involved in a transaction (e.g. Prahalad and Ramaswamy, 2004; Andreu et al 2010, Weigland and Arachchige, 2009 and Mukhtar, 2011). The main focus of frameworks and models seem to focus on the B2C perspective where customers and firms cocreate value (e.g. Prahalad and Ramaswamy, 2004, Payne et al 2008 and Andreu et al, 2010). Research with a focus on a B2B perspective are scarce, one of few examples is Sarker et al (2012) who makes an interpretive research on ERP vendors and their partnerships with consultancy firms selling, installing and improving the product build by the ERP vendor. The encounter epithet aims to visualize and explain how value is not an exchange between two parties but instead consist of collaborative networks that have the potential of cocreating value (Romero and Molina, 2009). Thus, the proposed models and frameworks bring forward an important feature of value cocreation that differ from traditional value models focused on value exchange i.e how value is created in collaborative endeavor (ibid).

Value in use as opposed to value in exchange (Vargo et al, 2008; Grönroos, 2008) is a difference in vocabulary between cocreation and traditional value creation. By using value in use the value creation process automatically becomes a joint effort where the actors co-create value in a collaborative way. An example is how a car does not generate value until it is being driven and thus the driver’s experiences and knowledge on how to drive the car becomes an important input for the value creating process, whereas the producing company contributes with the car itself. This might seem far-fetched but taking IS as another example it might become more obvious in a computer system can create great value for a company if it is supporting a working processes. While at another company the exact same system might be used in a contra productive way thus reducing value for the company. The value in use perspective has influenced marketing and strategic consideration to become more inclusive (Grönroos, 2008). The highlighting of the importance of context for value creating activities (Wigeland and Arachchige, 2009; Payne et al, 2008) is another important similarity found between existing frameworks.

Table 1 shows each aspect with corresponding field(s) of theoretical support and reference.
### Table 1. Overview of previous research

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Theory</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Production</td>
<td>Cobb and Douglas, 1928</td>
</tr>
<tr>
<td></td>
<td>Competitive strategy</td>
<td>Porter, 1980</td>
</tr>
<tr>
<td></td>
<td>Consumer</td>
<td>Debreu, 1959; Lancaster, 1966; Barnett et al, 2000</td>
</tr>
<tr>
<td>Cocreation</td>
<td>Service dominant logic</td>
<td>Vargo and Lusch, 1996; Chesbrough and Spohrer, 2006</td>
</tr>
<tr>
<td></td>
<td>Service science</td>
<td>Vargo and Lusch, 1996; Lusch and Vargo 2006</td>
</tr>
<tr>
<td></td>
<td>Consumer</td>
<td>Chesbrough and Spohrer, 2006; Vargo et al 2008; Prahalad and Ramaswamy, 2004</td>
</tr>
<tr>
<td>Cocreation</td>
<td>Resource Based View</td>
<td>Wernerfeldt, 1984; Barney, 1996</td>
</tr>
</tbody>
</table>

In this paper, we have selected the Value Encounter Model (VEM) by Weigeland and Arachchige, 2009 as a tool for modeling value cocreation. VEM is an extension of the traditional e3-value model. This paper builds on a continuation of Nilsson and Uppströms (2012) study of cocreation in value encounters in a public service system. Their study (Ibid) highlight the challenge and need to capture the values to-and from IT-platforms in a cocreation setting. By doing this, it will be possible to have a more nuanced view regarding platform design and interface for respective platform stakeholder. VEM suggest analyzing an encounter from four perspectives, namely value activity analysis, knowledge management, social network (social capital) management and operational management in order to get a broad view and understanding of the cocreation within respective value encounter. In this paper, we present the first step in VEM namely value activity analysis.

### 2.2 Platform as a Service and Packaged Software

Packaged software such as ERP and CRM systems have since the mid 1990’s become commonplace components in business infrastructures (Grabski et al, 2012). Despite the many drawbacks reported from implementations gone wrong (Davenport, 1998; Carr, 2003; McAfee and Brynjolfsson, 2008) the market continues to grow with 7% per year (Montgomery, 2012).

During the past couple of years, there have been numerous indications that the market for packaged software is fundamentally changing. With the rise of alternative delivery models such as SaaS and other notions related to cloud computing (Ghormley, 2012; Schenk and Guittard, 2009), industry analysts such as Gartner and Forrester expected the market to experience a radical shift during the end of the first decade in the 21st century (Magnusson et al, 2012). Traditional ERP and CRM models have included on-site installations and substantial configuration initiatives, often making implementations of these systems cumbersome and lengthy. With the rise of a model for packaged software delivered via the Internet, according to a pay-per-view logic of services, the traditional business model of the mega-vendors (SAP, Oracle and Microsoft) was under pressure from smaller, more adaptable players building directly on the emerging technological platform (Magnusson et al, 2012).

According to Weinhardt et al (2009), one of the major trends currently impacting the ERP market is the shift to services and the re-building of traditional ERP vendors into PaaS actors. Instead of controlling the development of functionality in-house, the vendor creates and distributes a development platform and incentive programs for enticing independent software vendors (ISVs) to create functionality through a process of open innovation (Ku and Cho, 2011; Kim, Kim and Lee, 2010; Nambisan and Sawhney, 2011). Functionality from ISVs is then made available to the PaaS customer, most commonly through some sort of a marketplace. Within packaged software, Salesforce.com’s AppExchange was the first of these marketplaces to be acknowledged as successful (Nambisan and Sawhney, 2011; Zittrain, 2009).
3. METHOD

In mid 2011, the researchers involved in this study were contacted by an ERP vendor concerning a potential research project. The research project aimed to investigate potential business models surrounding an ERP app-store initiative that had already begun. The ERP vendor (SMErp) is the largest ERP vendor in Sweden within the SME segment. For the empirical selection, the research project initiated discussions with informal representatives from the various stakeholders to identify potential interview respondents. This resulted in a list of 20 individuals (7 SMErp, 10 Partner, 3 Customers).

Throughout the spring of 2012, a series of 20 interviews were conducted with representatives from the ecosystem. The interviews were semi-unstructured character, resting solely on three questions (previous, current and future states) and a short introduction by the researcher. All interviews were sound-recorded and transcribed, and handled with the appropriate confidentiality. In parallel with the interviews, the research group gathered documentation related to the current business model and initiative. This included minutes from internal meetings, presentation material from partner gatherings and project documentation.

On the basis of the gathered empirical material, two activities were conducted. First, a chronological, revelatory case of the ERP app store initiative was created (for a detailed description, see Magnusson and Nilsson, 2013). Second, a mapping of value encounters according to VEM was performed. During this activity, the researchers worked in parallel with individual representations of the value encounters of an a-priori agreed upon scenario. After this, the two individual representations were compared in a joint workshop, and a consensus representation was created. With only minor discrepancies between the two individual representations, the overall reliability of the results is deemed high.

4. RESULTS

The results are organized following the logic of VEM. First, a scenario (the introduction of a new app into the app store) is presented to guide the reader in the modeled encounters, and second a rudimentary VEM analysis is presented.

- Partner 1 develops and package a customization of functionality, App X
- Partner 1 implements App X to Customer A
- Partner 1 publishes App X on an App market
- Customer B discovers AppX on the marketplace
- Customer B asks Partner 1 to implement App X
- Partner 1 helps Customer B to purchase and implement AppX

Figure 1. Scenario in ecosystem

In the scenario, there are a number of encounters between various stakeholders. Worth noticing is that a majority of the encounters are between a stakeholder and the platform, not between stakeholders (with one exception). Each encounter is modeled in Figure 2, the value created in the encounter is shown in green, and the arrow direction indicates who receives the value.
In table 2 the identified encounters taking place within the ecosystem along with the subsequent values are presented.

Table 2. Summary of value per encounter

<table>
<thead>
<tr>
<th>Encounter</th>
<th>Description of value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMErp – App Development &amp; App</td>
<td>SMErp (the vendor) supplies the technical infrastructure, e.i. the platform for partners to package ERP customizations as Apps and the marketplace for trading of Apps. In terms of value, SMErp receives partner compliance and efficiency, revenue from certification of compliance, increased visibility of core ERP due to increased vertical specialization.</td>
</tr>
<tr>
<td>market</td>
<td></td>
</tr>
<tr>
<td>Partner A – Customer A</td>
<td>Partner A orders and receives a customization of their ERP system from Partner A. Partner A receives revenue from sale of customization and package the customization as App X.</td>
</tr>
<tr>
<td>Partner A – App Development</td>
<td>Partner A uses App Development platform to develop and package App X. In order to do so, Partner A and complies to the rules, methods and regulations for App development. Partner A pays a recurring fee to have access to the App Development platform and remain certified.</td>
</tr>
<tr>
<td>Partner A – App Market</td>
<td>Partner A decides that App X does not contain any sensitive IP rights and that the App is suitable for publication in the App market. This gives Partner A potential future revenue from selling the same customization (the App) several times and visibility in the ecosystem</td>
</tr>
</tbody>
</table>
Customer B – App Market
Customer B finds several interesting ways to enhance the use of the ERP system when browsing the App Market. In addition, Customer B receives a good overview of the eco-system, the main actors and their core verticals.

Customer B - Partner B
Customer B orders, pays and receives App X from Partner B. Partner B makes necessary small modifications to App X.

Partner B – App Market
Via the App Market, Partner B has access to a significant resource base for pre-packaged and quality assured customizations (Apps). Partner B purchases App X from the marketplace on behalf of Customer B, makes necessary adaptations before delivery.

In terms of values per actor, these are presented in Table 3.

<table>
<thead>
<tr>
<th>Actor</th>
<th>Description of value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMErp</td>
<td>partner efficiency, compliance, $ and visibility</td>
</tr>
<tr>
<td>Partner</td>
<td>infrastructure, compliance, $, reuse, visibility, functionality, resource-base</td>
</tr>
<tr>
<td>Customer</td>
<td>apps, awareness, possibilities</td>
</tr>
</tbody>
</table>

5. DISCUSSION
By using the notion of value encounters on the context of ERP platforms we have discovered a wide, disparate range of values being created. As there are several actors simultaneously receiving different values associated to the same activity, this is regarded as a clear case of value cocreation (initial). From a value perspective, we summarize the value cocreation into six categories related to collaboration between SMErp, the Partners, and the customers. At the same time we see an emerging structure where values are cocreated related to two distinct functions of the platform as such, the development environment and the market environment.

With regard to the development environment, cocreation of value occurs through:
- **Competition** between the partners in the way new functionality is developed.
- **Standardization** in the way new functionality is developed leads much easier collaboration internally in the development.
- **Quality assurance** by following a certified method leads to trust from external stakeholders.

With regard to the market environment, cocreation of value occurs through:
- **Competition** regarding market price.
- **Visibility** of a wide range of apps, critical mass of users, partners, important for challenging SMErp vendors in position to larger vendors.
- **Transparency** regarding the rules and regulations for actors using the App development and the App market (e.i. the platform) provides internal- as well as external actors with a solid understanding of how value is created within the ecosystem.

However, we have also identified new, previously unexplored, types of values cocreated in the value encounters. These are the values that may be attributed to the platform itself e.i. the five encounters where the arrow points to the platform in figure 1. As the platform is not an actual actor, but rather an intangible artifact, it is difficult but very interesting to have made explicit also these ‘Platform values’ (PV). What happens to the PVs if they are not realized? This is an apparent danger since there are no explicitly developed platform mechanisms for realizing them. We have seen several indications of overly positive Partners and a challenge to find plausible explanations for this attitude. One possible explanation is that unrealized PV is channeled towards platform development and growth and thus is the explanation for the generally very positive attitude in the ecosystem. In that sense, the PVs that are unrealized by other actors (through opportunistic behavior) is an investment in the platform. Google adwords and Windows phone are two examples of Platforms where the platform owner have had an initial strategy to reach a critical mass of...
actors, activities and interactions before implementing revenue generating mechanisms. This strategy had low or no barriers for entry and an almost 100% re-investment of the PVs back to the platform. Google Adwords have successfully developed this initial strategy to a commercially successful platform strategy driving significant revenue by a combination of new and established partners.

The findings of this paper has implications for both research and management. In terms of research, the finding that the platform itself is an actor with attributable values through the interorganizational collaboration between customers, vendor and partners. This has previously been identified by Gawer (2009), yet is largely overlooked in contemporary research on platforms. We see this as a shortcoming that could be addressed through a research approach more informed by for instance the socio-material perspective (Orlikowski, 2007). As seen in the works of Kallinikos (2012), this perspective has ample strengths for the study of packaged software.

In terms of implications for management, the findings address the necessity for the involved actors to carefully assess the value cocreated before commencing the collaboration and creating the ecosystem. VEM has proved to be a powerful method for modeling the cocreation of value, whereby we advise managers involved in this type of a collaboration to carefully review potential benefits of utilizing the model before applying a new business model. Value is cocreated, and the division of value will become a central governance mechanism in the future business model. Without a clear understanding of what value should be assigned to which actor, we believe the viability of the business model may suffer (Magnusson and Nilsson, 2013).

REFERENCES

Arnould, Service-dominant logic and resource theory, Journal Academy of Market Science, 36, 200, 8 pp. 21–24
Gawer, A. (Ed.) (2009), Platforms, Markets and Innovation, Edward Elgar, Cheltenham, UK.
Gawner, A. Platforms, Markets and Innovation, Edward Elgar publishing limited, Cheltenham, UK, 2009


Maglio, J. Spohrer, Fundamentals of service


Ng, R., Maull, N. Y., Outcome-based contracts as a driver for systems thinking and service-dominant logic in service science: Evidence from the defence industry. European Management Journal Vol. 27, No. 6, pp. 377–387, 2009


Porter, Competitive strategy New York, Free Press 1980


Ramaswamy, Leading the transformation to co-creation of value, Strategy & Leadership, Vol. 37 No. 2, pp.32 – 37, 200


INVESTIGATING THE EFFECTS OF INNOVATIVE TECHNOLOGY ON SMARTPHONE USAGE WITH AFFORDANCE THEORY

Chin-Fu Ho\textsuperscript{1} and Jo-Peng Tsai\textsuperscript{2}

\textsuperscript{1}Department of Information Management, National Sun Yat-Sen University, No. 70, Lienhai Rd., Kaohsiung 80424, Taiwan
\textsuperscript{2}Department of Computer Science & Information Engineering, Far East University, No.49, Zhonghua Rd., Xinshi Dist., Tainan City 74448, Taiwan

ABSTRACT
The main research stream on customer attitudes towards adopting ICT artifacts focuses chiefly on the variables and relations in the extensive technology acceptance model (TAM) and its antecedents, but less on the design factors of the product itself. This limits the accuracy of explanations for the causes of ICT artifact adoption, while failing to examine the design features supporting satisfactory user interfaces. Therefore, in order to alleviate this defect, this study investigates a contextualized usage on smartphone from a sequence of stages including design features, functional affordance, descriptive beliefs and inferential beliefs based on the affordance theoretical perspective. After the investigating process on the functional features of the smartphone, we derived two affordance-based inferential beliefs: diversity and intuition. Then a context-based TAM model is developed by using these two affordance-based variables along with variables from Innovation Diffusion Theory (IDT) as the antecedents of the traditional TAM model. The research results based on a questionnaire survey indicate that both diversity and intuition have significantly positive effects on perceived ease of use (PEOU) but only diversity has significant effects on perceived usefulness (PU). Of the IDT variables, only relative advantage is statistically significant for attitudes. The proposed model based on the affordance approach provides a more accurate technology-based explanation and produces more extensive knowledge based on the actual usage of product functionality.

KEYWORDS
Smartphone; Affordance Theory; Context-based TAM Model; User Interface; Diversity; Intuition.

1. INTRODUCTION
Smartphone has become an indispensable necessity for many workers. Aside from the basic communications functions found in traditional cellphones, smartphone can run myriad applications, turning the once single-purpose cellphone into a mobile computer. Innovative “application stores” allow individual users to download and install a variety of interesting or useful tools at acceptable prices, while providing software developers with a market platform and considerable reward opportunities. Given its fast sales growth and the potential of related commercial applications, smartphone has attracted considerable commercial and academic attention.

Of the many studies on the acceptance and adoption of ICT artifacts for various user domains, most have focused on inferential beliefs such as perceived usefulness (PU) and perceived ease of use (PEOU), or the antecedents of these two variables. Benbasat and Barki (2007) criticized this kind of research on user attitudes towards ICT artifacts has failed to provide insight into what makes an IT useful. Moreover, Tate and Evermann (2009) suggested that many existing theories of user perceptions and attitudes towards technology suffer from “over-investigation” on user attitudes and “under-investigation” on the technology. However, for the authors’ best knowledge, there is little empirical papers to investigate the effect of innovative ICT products based their design factors. Therefore, in order to alleviate the defects of the extensive TAM model and profoundly realize customer’ attitudes towards ICT products, it may be a feasible direction to innovate the mature TAM model with integrating the design related theory - affordance theory. For the above-
mentioned reasons, in this paper, we apply an affordance theoretical perspective to investigate the effects of innovative technology on smartphone usage and to propose an innovative context-based TAM model for ICT adoption research.

2. AFFORDANCE-BASED BELIEFS FOR SMARTPHONE USAGE

The perceived functional affordances of technology products provide some salient features which contribute to the theoretical basis for user attitudes and perceptions towards ICT artifact adoption. Tate and Evermann (2009) suggested that social psychology informs our understanding of how affordances form descriptive beliefs, which then lead to inferential beliefs and ultimately to attitudes towards technologies. This insight provides a practical and useful direction for investigating user attitudes towards smartphone adoption. For an ICT product, a well-designed human computer interface (HCI) might be a critical success factor, and HCI research has thus assumed new importance. Norman (1990) argued that designers should try to make designs simple to use and simple to understand, yet still powerful enough to accomplish the product’s functionality goals. He considered product appearance to be less important than usability and understandability, which he suggested could be better accomplished by providing a good conceptual model and making things visible. Nielsen (1994) studied the explanatory power of usability heuristics based on a factor analysis of explanations, and found that the two most important factors relating to usability explanations were visibility of system status and match between system and real world.

Current smartphones include many HCI functional features. For example, multi-touch panel technology has increased the convenience of the operational interface, and application developers have taken advantage of built-in sensors to develop interesting and practical applications. For example, the multi-touch function includes swipe, pinch, unpinch, flick and sketch operations. These functional features can provide the basis for affordances for web surfing, word processing and document presentation and reading. Moreover, the gyroscope function affords self-adaptive viewing orientation. The multi-touch and gyroscope functions are designed based on human’s usage habits. After experiencing the operation on the smartphone HCI, the user may perceive the smartphone as facilitating useful work through intuitive operations such as web surfing, word processing, image presentation, and document reading (descriptive beliefs). Through the accumulation of self-experiences, descriptive beliefs and reception of relating information, the user might perceive the smartphone’s HCI operation as intuitive, especially in comparison with the operation of traditional cellphones. Therefore, in this paper, we propose “intuition” as an affordance-based inferential belief and use it as an antecedent of both the ease of use and usefulness variables in the TAM theory.

Advances in electronic manufacturing technology have enabled the embedding of diverse sensors in smartphones. These sensors are a key part of what makes smartphones “smart”. Today’s smartphone is more than just a mobile phone or computer - it is a mobile device integrating communications, computing and sensing, and application developers have leveraged this new capability to develop a variety of innovative mobile applications including somatosensory games and musical instruments (Reis et al. 2009) such as the Smule ocarina (http://ocarina.smule.com/). Future smartphones will feature a broader arrays of embedded sensors, allowing software developers to create more innovative and practical mobile applications.

For example, the accelerometer (functional feature) can detect acceleration (functional affordance). Application developers can exploit this functional affordance to develop innovative mobile applications in which, for example, the user changes the currently playing song by shaking the smartphone rather than with traditional button tapping mode. After experiencing the operation of the smartphone HCI, the user might perceive that the smartphone affords diverse input modes (e.g., afford song selection by shaking, button tapping, etc.). This is a perception of self-experience (descriptive beliefs). In other words, a smartphone’s innovative HCI technology provides its functional features. People who experience these functional affordances then generate a positive evaluation for the smartphone (descriptive beliefs). After accumulating self-experience or information from other users or media (e.g., newspapers, magazines, commercial advertisements, etc.), users may find more available HCI operational modes. Then they infer that a smartphone includes diverse operation modes which afford diverse utility to provide convenience in work or everyday life (inferential beliefs). Therefore, in this paper, we also propose “diversity” as another affordance-based inferential belief and use it as an antecedent of both the ease of use and utility variables in the TAM theory.
3. CONCEPTUAL FRAMEWORK AND HYPOTHESES

In the Sec. 2, we have explored two more specific inferential beliefs, diversity and intuition, as antecedents of PU and PEOU. These are deduced based on the functional affordance and descriptive beliefs of smartphone usage. Intuition and diversity, along with some variables in IDT, are then used to investigate user attitudes towards smartphone usage, based on the TAM theoretical foundation. Fig 1. shows the conceptual framework and hypotheses proposed in this paper. The basis and explanation of the hypotheses in the conceptual framework are depicted as below.

There exist many design principles proposed for HCI design. Nielsen (1994) posited that HCI should provide flexibility and efficiency. McKay (1999) divided users into three fundamental types - beginner, intermediate, and advanced, saying, “if your program uses only context menus to accomplish a task, chances are that a beginning user won’t be able to figure out how to do that task.” However, as beginning users will quickly become intermediate users, he emphasized the user interface should focus on accommodating intermediate and advanced users, while being accessible to beginners. Robbins et al. (2008) suggested that most smartphone applications erroneously assume a user is giving the device and the current application his full attention. Given that smartphones are designed to be used while the user is mobile, the user interface should provide the user with the ability to initiate commands while devoting only limited attention to the device (or even looking away from the device), and still easily understand how the display has changed. Based on the aforementioned arguments, we propose that diversity might be an important design factor for smartphone user interfaces and hypothesize that:

H1a: Increased diversity of innovative technology on the user interface will positively influence perceived usefulness (PU) for the smartphone usage.

H1b: Increased diversity of innovative technology on the user interface will positively influence perceived ease of use (PEOU) for the smartphone usage.

Exploring usability heuristics, Nielsen (1994) found that some design factors such as “match between system and the real world”, “aesthetic and minimalist design”, and “recognition rather than recall” are important factors for user interface design. McKay (1999) suggested that affordance relates to a user’s ability to determine how to use an object just by looking at visual clues, and that a good user interface should be made “intuitive” through keeping its visual or functional features consistent within the program with real-life experience. Based on the above-mentioned literature, we propose that intuition might be also an important design factor for smartphone user interfaces and hypothesize that:

H2a: Increased intuitiveness of innovative technology on the user interface will positively influence perceived usefulness (PU) for the smartphone usage.

H2b: Increased intuitiveness of innovative technology on the user interface will positively influence perceived ease of use (PEOU) for the smartphone usage.

Rogers (1983) suggested that the characteristics of innovations - relative advantage, trialability, observability and compatibility influence the individual’s decision to adopt a particular innovation. Moore and Benbasat (1991) also pointed out that relative advantage and compatibility are the main factors in innovation adoption. Plouffe et al. (2001) also showed that relative advantage, compatibility, image, visibility, and trialability have significant effects on innovation adoption. Based on these findings, we hypothesize that:

H3: Increased compatibility of innovative technology on the user interface will positively influence user attitudes towards smartphone usage.

Though Moore and Benbasat (1991) proposed that the concept of Roger’s relative advantage is similar to TAM’s perceived usefulness, many scholars believe there is a difference between them while simultaneously analyze the effects of relative advantage and perceived usefulness on the use intention (Carter and Bélange 2005; Plouffe et al. 2001). Therefore, this study also analyzes the influence of relative advantage and perceived usefulness over attitude, hypothesizing that:

H4: The relative advantages of innovative technology on user interface will positively influence user attitudes towards smartphone usage.

Moore and Benbasat (1991) divided Roger’s observability (1983) into visibility and result demonstration. Following Moore and Benbasat’s definition of visibility and Rogers’ definition of observability, we refer to visibility and observability as the same constructs in this paper. Hsu et al. (2007) revealed that visibility (observability) has a positive influence on the intention to use multimedia message service on mobile phones. Park and Chen (2007) empirically confirmed that observability was positively related with smartphone
adoption among medical doctors and nurses. Previous studies have also indicated that trialability and observability (visibility) have a positive influence on attitude and intention to adopt innovative IT (Plouffe et al. 2001; Wu and Wu 2005). Thus, we hypothesize that:

H5: The trialability of an innovative technology on the user interface will positively influence attitudes towards smartphone usage.

H6: The observability of an innovative technology on the user interface will positively influence user attitudes towards smartphone usage.

Prior studies on TAM’s application in information management have confirmed that user attitudes or intentions are largely influenced by perceived usefulness and perceived ease of use (Davis et al. 1989; Park and Chen 2007; Schierz et al. 2010). Yang (2005) explored the factors affecting the adoption of mobile commerce, finding that perceived ease of use positively influences perceived usefulness, which then has a positive influence on attitudes towards using mobile commerce. Chen et al. (2009) investigated the acceptance and diffusion of innovative smartphone use logistics company with four competing models; all empirical data for the four models revealed that perceived ease of use positively influences perceived usefulness. Hence, we hypothesize that:

H7: The user’s perceived ease of use of a smartphone will positively influence the perceived usefulness of a smartphone.

H8: The user’s perceived ease of use of a smartphone will positively influence user attitudes towards smartphone usage.

H9: The user’s perceived usefulness of use of a smartphone will positively influence user attitudes towards smartphone usage.

4. RESEARCH METHOD AND DATA ANALYSIS

This study uses a sample survey methodology to test the research hypotheses and the proposed model. A theoretically grounded questionnaire is developed to solicit responses from Taiwan consumers about their perception for the user interface of a smartphone. To validate the survey instrument, both a pre-test and a pilot test were conducted prior to the initiation of the large-scale survey. For the pre-test, the questionnaire was administered in face-to-face interviews to 10 smartphone users and related experts. Feedback was obtained about the length of the instrument, the format of the scales, factors forgotten to take into account and ambiguous points in the questions. The respondents also provided terminologies relating to smartphone function and use, which were then used to modify the questionnaire. The questionnaires for the pilot test were completed by 64 respondents, of which 57 were complete and valid. The data obtained from the pilot study were examined for completeness of responses, reliability, and construct validity.

The survey was administered online. Prior to implementing the main survey, a pre-test and a pilot test were administered to validate the instrument. The online survey received 410 responses which were then subjected to a three-stage screening process. First, we eliminated respondents without smartphone use experience. Subsequently, incomplete or unusual responses were deleted. Finally, outliers in the remaining questionnaires are eliminated. This left 331 usable responses.

Personal demographic data was solicited regarding smartphone use experience, gender, age, occupation, education and income. Table 1 presents the respondents’ demographic profiles, showing that users are relatively young. Of the 331 valid responses, 225 respondents (68%) own their own smartphones, while 106 respondents (32%) don’t personally own a smartphone but have used one. Of the valid responses, 78.5% were male and 21.5% were female.

The Cronbach’s alpha reliability coefficient (Cronbach 1951) was used to measure the reliability of all instruments. The respective coefficient alphas (Cronbach’s alphas) for the diversity, intuition, compatibility, relative advantage, trialability, observability, perceived usefulness, perceived ease of use and attitudes towards usage constructs were 0.779, 0.823, 0.823, 0.757, 0.744, 0.717, 0.909, 0.901 and 0.864, indicating an acceptable level of reliability (>0.70) (Nunnally 1978). Factor analysis was used to measuring construct validity. A good rule of thumb for determining the number of factors is the “eigenvalue greater than 1.0” criteria (Stevens 1986). The results from the factor analysis support the validity of the measurement instrument.
Confirmatory factor analysis (CFA) is used to analyze scale validity in the measurement model (Segars and Grover 1993). The evaluation results for the measurement model show a good fit with $\chi^2/df$ (1.918), AGFI (0.809), GFI (0.839), NFI (0.842), NNFI (0.906), and RMSEA (0.054). Table 2 presents the test results of reliabilities and convergent validities for the model, all of which indicate a relatively high degree of reliability and validity. Table 3 shows the test results of discriminant validity. The causal structure of the proposed theoretical framework is examined using the structural equation model (Hair et al. 1998). Goodness-of-fit indices for the proposed model are $\chi^2/df$ (1.96), AGFI (0.811), GFI (0.838), NFI (0.84), NNFI (0.907), and RMSEA (0.054). NFI is slightly outside acceptable levels, but the all other indices are acceptable. The results of the structural equation modeling analysis is shown in Fig. 2.

![Figure 1. Conceptual framework and hypotheses.](image)

<table>
<thead>
<tr>
<th>Table 1. Demographic profile.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Occupation</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Monthly Income</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*1 US$ is about 30 NT

<table>
<thead>
<tr>
<th>Constructs</th>
<th>AVE</th>
<th>CR</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity</td>
<td>0.53</td>
<td>0.816</td>
<td>0.779</td>
</tr>
<tr>
<td>Intuition</td>
<td>0.54</td>
<td>0.825</td>
<td>0.823</td>
</tr>
<tr>
<td>Compatibility</td>
<td>0.62</td>
<td>0.868</td>
<td>0.823</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>0.47</td>
<td>0.777</td>
<td>0.757</td>
</tr>
<tr>
<td>Trialability</td>
<td>0.61</td>
<td>0.819</td>
<td>0.744</td>
</tr>
<tr>
<td>Observability</td>
<td>0.6</td>
<td>0.737</td>
<td>0.717</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>0.6</td>
<td>0.898</td>
<td>0.909</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>0.61</td>
<td>0.902</td>
<td>0.901</td>
</tr>
<tr>
<td>Attitudes towards usage</td>
<td>0.56</td>
<td>0.833</td>
<td>0.864</td>
</tr>
</tbody>
</table>

AVE: Average Variance Extracted; CR: Composite Reliability.
5. DISCUSSION AND IMPLICATIONS

Research results indicate that diversity has a similarly significant positive effect on perceived usefulness and on perceived ease of use (Fig. 2). This indicates that providing additional innovative operation modes on the smartphone user interface might enhance the user’s perception that the smartphone is useful and easy to use in the user’s work or daily life routines. Nevertheless, the innovative functional features represented by the diversity construct originate from advances in smartphone technology. This result and phenomenon may provide a feasible solution to alleviate the criticism on TAM model by Benbasat and Barki (2007) that it does not substantially extend that knowledge to a broader or more specific set of relationships, especially those concerned with design. Moreover, this implies that managers or designers should take advantage of current advanced technology to develop diverse functional user interface features and applications for smartphones to attract the attention and affection of users.

The effect of intuition on PEOU is significant but not on PU. A plausible explanation might be that the user perceives usefulness is different from ease of use. Perhaps intuition could provide advantages such as operational fluency, which would increase the user’s perception of ease of use. However, this can not ensure its usefulness for assistance of work, amusement or daily life activities. It implies that verifying the usefulness of smartphones for users should require to consider other factors. This might provide an insight for managers and designers that they could develop intuitive operation modes of smartphone user interfaces to enhance the user’s perception of ease of use.

Table 3. Test results of discriminant validity.

<table>
<thead>
<tr>
<th></th>
<th>DI</th>
<th>IN</th>
<th>CO</th>
<th>RA</th>
<th>TR</th>
<th>OB</th>
<th>PU</th>
<th>EU</th>
<th>AT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IN</td>
<td>0.44</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>0.54</td>
<td>0.34</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RA</td>
<td>0.52</td>
<td>0.70</td>
<td>0.42</td>
<td>0.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR</td>
<td>0.15</td>
<td>0.34</td>
<td>0.04</td>
<td>0.33</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OB</td>
<td>0.23</td>
<td>0.29</td>
<td>0.27</td>
<td>0.39</td>
<td>0.26</td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU</td>
<td>0.45</td>
<td>0.28</td>
<td>0.64</td>
<td>0.36</td>
<td>0.15</td>
<td>0.23</td>
<td>0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU</td>
<td>0.48</td>
<td>0.44</td>
<td>0.50</td>
<td>0.52</td>
<td>0.14</td>
<td>0.30</td>
<td>0.41</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>AT</td>
<td>0.56</td>
<td>0.46</td>
<td>0.61</td>
<td>0.55</td>
<td>0.12</td>
<td>0.33</td>
<td>0.74</td>
<td>0.67</td>
<td>0.75</td>
</tr>
</tbody>
</table>

DI: Diversity; IN: Intuition; CO: Compatibility; RA: Relative advantage; TR: Trialability; OB: Observability; PU: Perceived usefulness; EU: Perceived ease of use; AT: Attitudes toward usage

Figure 2. Results of the structural equation modeling analysis.

* p<0.05; ** p<0.01; *** p<0.001.
Among the effects of IDT variables on attitudes, only relative advantage is statistically significant. This is consistent with previous studies (Hsu et al. 2007, Plouffe et al. 2001, Wu and Wu 2005). This finding provides an insight that smartphone vendors should concern about the comparison of innovative and advanced functional features between their products and those of their competitors. The influence of compatibility on attitudes towards smartphone usage is not significant. This result is inconsistent with prior studies on attitudes towards smartphone adoption, such as Chen et al. (2009) and Puter and Park (2010). The effect of trialability on attitudes is negative but not significant, which agrees with prior findings by Karahanna et al. (1999), Hsu et al. (2007), and Park and Chen (2007). The effect of observability on attitudes is positive, but not significant, which is consistent with Chen et al. (2009) and similar to Hsu et al. (2007) for the experienced users.

Empirical data show that attitudes toward smartphone usage are largely influenced by PU and PEOU. Furthermore, PEOU positively determines PU, and the effect of PU on attitudes is stronger than that of PEOU. This result is consistent with previous TAM research (Park and Chen 2007, Schierz et al. 2010) and may imply that the usefulness for work and everyday life routines is more influential than ease of use in determining attitudes towards smartphone usage.

6. CONCLUSION

From the affordance theoretical perspective, this study deduces two new design (or technology) oriented variables which affect attitudes towards smartphone usage. These two variables, diversity and intuition, are derived from affordance of a smartphone, and are distinctly different from the antecedent variables of PU or PEOU (e.g., trust, self-efficacy, job relevance, information quality and system quality) in previous studies based on the extensive TAM models. They provide a more accurate and meaningful explanation for user attitudes towards smartphones based on a technological design perspective.

The research results presented in this study also provide practitioners with guidance to alleviate the gulf between designer and user by encouraging the designer to consider the key factors influencing user attitudes towards smartphone adoption. The proposed model’s applicability and theoretical validity were validated by investigating the factors influencing consumer attitudes towards smartphone usage, including two affordance-based inferential beliefs (diversity and intuition), four IDT-based factors (comparability, relative advantage, trialability and observability) and two TAM-based factors (perceived usefulness and perceived ease of use). The empirical results indicate that diversity and intuition have the greatest influence on smartphone usage. Understanding the factors and conditions facilitating smartphone usage might help managers rationalize marketing strategies and convince designers to follow effective guidelines during the design process.

ACKNOWLEDGEMENT

This work was partially supported by the National Science Council (NSC), Taiwan, ROC, under Grant NSC 97-2410-H-110-031 and NSC 98-2410-H-110-006.

REFERENCES


ABSTRACT
The existing models meant to help in the ICT investments process are too heavy and technical to be used in SMEs. This paper reports the results of a case study in which the users carry out an ICT investment by applying the Collaborative Software Acquisition (COSA) model. The COSA model applies user participation and team-working in the acquisition of Commercial Off-The-Shelf (COTS) software products. The results show that the users are willing to commit to the COSA process. However, problems exist related to analysing system requirements and figuring out the system as a whole. The users should also investigate the existing COTS market before the requirement analysis and do the system requirements elicitation together with the evaluation of the existing COTS products.

KEYWORDS
COTS package selection, ICT investment, ICT adoption, software acquisition, organisational learning, user involvement

1. INTRODUCTION

As information technology is becoming a commodity available to everyone (Carr, 2004), it is also losing its strategic value. The business value of information technology does not come from the IT investment as such, but more likely how the information technology is applied and used in its business context (Melville et al., 2004). IT projects are not actually about IT at all, but about people using information and IT to execute business tasks and processes (Marchand and Hykes 2006). The benefit of IT will be realized after people interact with information and IT in a way that brings the expected outcomes. A powerful way to get people to adopt the change, is to involve them in the change initiative already at the start of the project. It is widely shown (Franz & Robey, 1986; Kunda & Brooks, 1999; Caldeira & Ward, 2002, Kwasi, 2007; Bjerknes & Bratteteig, 1995; Verville et al. 2005) that the users, when having the possibility to be involved in the design and implementation of their ICT systems, they also recognize the usefulness of the system in their work. In this ICT-driven change process, the users may participate in decisions during system development (Kensing 2008) or be involved in the final acquisition process of the software package.

The ICT acquisition process, including finding and selecting the right commercial-off-the-shelf software (COTS) package, is a big challenge for the users. Plenty of models have been invented to help companies make the acquisition of new COTS easier (Jadhava & Sonar 2009). However, most of them do not address non-technical issues at all (Abdallah et al. 2007). Some models take human issues into account (Kunda 2003), but do not expect the selection to be done by the users alone. Letting the users do the job alone, becomes even more problematic, because the users are reluctant to use any formal methods at all (Sommerville et al. 1998; Ekanem & Smallbone, 2007).

This study tests the Collaborative Software Acquisition model (COSA) (Rantapuska & Ihanainen.O., 2008), which tries to allow the users to find, evaluate and select the COTS package which is designed to be used in their own work. The COSA model applies the concepts of organizational learning (OL) (Nonaka, 1994) in order to bring the software acquisition, as much as possible, close to the users. The COSA model was tested one time earlier in a small importing company (Rantapuska & Sore 2010).

The rest of the paper is organized as follows: Firstly, we present the research problem, framework and method. Secondly, we describe our case project data and analyse the problems in relation to the COSA model. Finally, after wrapping up the core findings, we discuss the suggested changes to the COSA model.
2. CASE STUDY

2.1 Research Approach

2.1.1 Research Problem

This paper tests and evaluates the usability of the COSA model in defining user requirements and selecting the best COTS package for a specific domain. We analyse the collaboration and interaction of the team members, their work in relation to the COSA model and the capability of the model to support the team to elicit the software requirements, find and evaluate promising software candidates and finally, select the best COTS package for the final test. After probing and analysing problems in the COSA process, we suggest upgrades to the next COSA version. The research question is stated as follows:

- How well does the COSA model work?
- How well does the team follow the COSA process?
- How do collaboration and commitment evolve between team members during the COSA project lifetime?
- How well are the team members able to perform the COSA tasks?

2.1.2 Research Framework

According to Nonaka’s (1994) well-known theory of organisational learning, working knowledge is generated in a continuous interaction in human activity. As the work varies in generative dance (Cook & Brown, 1999) between social and individual dimensions, the knowledge used in that work takes two different forms: tacit and explicit. Tacit knowledge is tied into action and is usually unconscious and automatic in nature. Explicit knowledge is rational and usually expressed in a transferable form. The interplay between these two forms of knowledge goes through four phases of knowledge conversation. 1) In the socialization process, e.g. in personal conversations, the knowledge is transferred from tacit to tacit knowledge. 2) In the externalization process, people try to express their tacit understanding in explicit form, such as numbers and documents. 3) Analysis and document evaluation is a typical work of combination process in which explicit knowledge is converted into another explicit knowledge. Finally, 4) the explicit knowledge will be converted into tacit knowledge in the internalization process when users, for instance, learn to use an information system.

Collaborative Software Acquisition (COSA) (former name “Co-operative Software Acquisition Model”) model applies organizational learning (Nonaka 1994; Nonaka and Takeuchi, 1995) in COTS package acquisition and adoption. The model is designed as a business-oriented, easy-to-use and learning-and knowledge-oriented management. The idea of the model is that the users act in face-to-face meetings empowered with all decision rights and responsibilities for the decisions made.

The users act in various roles in a “knowledge creating team”: The knowledge officers are the managers supporting the team by providing resources and visionary ideas. The knowledge domain specialists know the work processes and the information needs of different stakeholders. The information specialists are responsible for the technology used in working processes. Still, the most important players are the knowledge practitioners. This group constitutes the “community of practice” (Brown & Duguid, 1991) which eventually forms the business value from the information systems.

The COSA model interprets the four stages of organisational learning into phases of COTS package acquisitions (Figure1). The building of the team can be regarded as the fifth phase (Phase 0).
In the initiation phase, the organization prepares to ensure communication, motivation and commitment of the participating people. The team must have knowledge officers as well as knowledge practitioners.

In the 1) externalization phase, the team members identify problems, share experiences and express the domain-specific tacit knowledge in explicit form. When doing so, the shared understanding about the goals, business tasks, needs and scope of the system will be specified. The goals are defined in terms of opportunities to be exploited and problems to be solved. The analysis of business tasks consists of listing the jobs and the tasks assigned in each job. When the team comes into a shared understanding about their goals and business tasks, they can elicit the needed characteristics of the software. When defining the scope of the system the team keeps the needs in a proper relation to the original goals set at the beginning of the phase.

In the 2) combination phase the team defines the requirements, selection criteria and searches for promising candidates. The requirements are specified by selecting the needs which must be resolved with the software. In order to form the selection criteria, the requirements are weighed in relation to each other. The team conducts a market search and creates a short listing of candidates for further evaluation.

The 3) internalisation phase serves as the final usability test of the candidate solutions. The team makes a plan regarding the process for adoption.

The 4) socialization phase is a diffusion process in which the skilled and active change agents (Markus & Benjamin, 1996) support the spread of software usage throughout the organization.

2.1.3 Research Methods

In this case study, the case company applies the COSA model to find a COTS software package for their own use. As testing an artefact, we chose a design science approach (Hevner, 2004) for our research methodology. We test COSA artefact in a real case project. Then, we evaluate the results and finally, define the implications to the next COSA version. The data covers three of the four phases of the COSA process: externalization, combination and internalization. The data is collected as participatory observation in team sessions. The researcher took on-site notes about the team meetings, had individual interviews with participants and collected documents of the meeting minutes. The interviews were recorded and transcribed on paper. The on-site notes are taken from 13 team sessions. The participants were interviewed three times: at the beginning, during and at the end of the case project. The important interpretations in analysis and key findings were also reviewed with the CEO of the case company.

The first interview focused on unfolding subjective feelings, attitudes, mental models and motivation towards the project. The themes of the interview were personal feelings, views about the goals, team roles, perception about the communication and work of the team as a whole. The second interview took place at the end of the externalization phase. In order to see the progress of collaboration in team working, the same
themes were discussed with the participants. The participants were asked about the quality and practicality of the communication and also about how well they could follow and contribute to the project.

We coded the interviews and team sessions by looking for any relevant expressions referring to the issues of the research questions. In our analysis, we first described the interviewees and sessions as objectively as possible. After that, we evaluated the sessions in the light of the predefined COSA tasks. How they followed the process, collaborated and performed the tasks. Based on the analysis, we wrote a short summary of each session. The personal interviews were used to help interpret the team sessions. In the final session, the participants were asked to evaluate the COSA process as a whole.

2.2 Data Analysis and Results

2.2.1 Research Data

The case organization is an industrial medium-sized engineering company employing approximately 90 people in four premises in Finland. They provide product development, mechanical engineering, plant engineering and electrical and automation engineering. They use the same CAD/CAM software as their customers use. Their original intention was to acquire COTS software for managing their office and technical documents.

According to the COSA model, the employees formed a working team to find a Product Document Management (PDM) software meeting their requirements. The team represented all stakeholders acting in different roles: two directors (CEO1, CEO2) of different business sites as knowledge officers and two industrial designers as knowledge specialists and users (D1, D2) and finally one IT support person (D3) as a specialist in information technology. D1 and D2 had experience in the field of industrial engineering for several years. D3 was also working in the company for more than three years. The project also had two students, one of them (S1) acting as the team leader. The researcher took part in the sessions and also helped with the COSA process when needed. The project had 13 sessions filling three of the four phases of COSA model. The sessions took approximately four hours each. The content of the sessions are listed in Table 1 below.

<table>
<thead>
<tr>
<th>Session</th>
<th>Phase</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-1</td>
<td>Team formation, goals of the system, roles and tasks</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Description of goals, problems, opportunities and jobs roles</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Goals, roles, task list and system scope</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Task content and requirements</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>Presentation of candidates (long list)</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>Presentation of candidate Alpha</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>Presentation of candidate Beta</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>Presentation of candidate Gamma</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>Presentation of candidate Delta</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>Summary of candidates</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>Testing of selected candidates</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>Evaluation of selected candidates (and COSA process)</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>Evaluation of COSA process</td>
</tr>
</tbody>
</table>

2.2.2 Description of the Project

Socialization and externalization

The team discussed the current situation, problems and opportunities. The goals of the system were defined as 1) limit search time of documents, 2) use metadata, enhance the use of space and improve availability and sharing of documents between company offices.

The project members listed some problems to be solved, such as: various versions of designs are not under control, the same parts are not used in designs, the designs do not resemble each other, information is missing, everybody does the work in his/her own way, searching and archiving of documents is difficult,
simultaneous work with the same design tasks is not possible and thus it is difficult to ensure that all needed documents have been prepared for a specific design. The possibilities were listed as: chance to deliver the list of parts to the customer, better tracking of design costs, cross-utilization of standard parts, using design patterns, sharing designs, searching by measurement values and content, automated category names and support of contemporary design methods (possibility to save uncompleted designs).

The participants discussed the existing job roles which might benefit from the new system. The job contents were also analysed by identifying the job content as a list of tasks as well as the information needed in each job. Finally, the group listed 25 features presenting the customer requirements as follows: list of documents, document search, document saving assistance, cancellation of tasks, revision control (undo), document flow, model document, project and customer based editing, multi-language use, remote use, connectivity with email, connectivity with ERP, connectivity with financial management, ease of use, component dictionary, reliability, data security, data transfer, maintainability, availability of updates, user interface, reliability, support, training and finally, license policy. The criteria were categorized and weighted as follows: functional requirements (40%), non-functional (technical) (30%), and vendor characteristics (10%) and cost factors (10%).

Combination

Based on the list of requirements, the students made an internet market search about the prospective PDM software. They found 13 software candidates from which the team selected 4 candidates for further evaluation and comparison. The vendors of all of the selected candidates were asked to demonstrate their application to the team. The vendors presented their company, demonstrated the application and finally, gave their answers for the list of requirements. Each team member evaluated every requirement of each candidate using a scale from 1 to 5. The weighted scoring table was used to select the best candidate for final test.

Internalization

As the test, the team gave the company a real and typical task to be solved with the system. When the test was successfully conducted, the company started to think about purchasing the software. Finally, after four months, the companies decided not to purchase the software at all.

2.2.3 Data Analysis

Socialization and externalization

The participants mentioned good atmosphere and communication because “everyone talked about the same thing” (D1) and “nobody shot down others’ ideas immediately” (CEO2). CEO1 took a role as an active and equal member of the team whereas CEO2 acted more as an observer. He thought that the designate software is primarily for the whole company and matters in their premises “are quite good”. D1 and D2 contributed to the work substantially. D2 was even prepared with his own analysis about the designer’s work content.

The discussion about the goals of the system was quite problem-centered including job performance and costs. The participants stated the goal for the project as one of “clarifying the situation” (A1) and “acquiring a document management system” (D2) or finding one candidate to “consider” (CEO1). The opportunities as a strategic issue were not discussed very much. There was no significant attention to the business opportunities in relation to changes in competitive environment or technology trends.

Discussions on system environment including job roles, system scope and task contents took three sessions. The team ended up with a list of job roles each including a list of tasks as follows: design (19 tasks), project management (13), purchasing (6), sales (3), production management (4), inventory management (4), general management (3), financial management (3) and IT support (9). The tasks covered all jobs related to designing and other jobs needing document management. There was a wide range of different types of documents to consider. Besides the job content itself, the discussion focused also on the level of abstraction and common needs in different job roles. The integration of the new system into the existing applications caused discussion as well.

The analysis of work content was considered important and that it was also good to know what “you actually do” (D1) and see that the same problems exist in different form in the other sites of the company. However, the team members also regarded the job content analysis as “repetitive” and “mind-numbing”. The jobs contain the same type tasks and the tasks overlap in job contents. The same things appeared over and over again in different contexts. Conceptualizing the total whole as jobs, tasks and related documents was also problematic. Which level of abstraction the task should be placed to also caused discussion. For example, many job roles include the task “working out a travel expense report”. It was difficult to decide if
this task was something belonging to many jobs or a task of a job on a more abstract level or maybe a separate administrative task. Whether the job should be analyzed as a hierarchy or as a sequence of tasks also raised discussion. This is the reason why the list of tasks became quite long and comprehensive.

The analysis of work content in relation to its information needs caused problems as well. The traditional classification of information as input, output, and stored information did not work in this context, especially when the task itself is knowledge intensive as is industrial design. In this type of task, the data usually acts in all its three roles: as input and stored data when starting the task and output data when finishing the task. This presented itself at the beginning of the analysis of job contents when the tasks were named by using a noun phrase only. For instance, “travel expense report”, “list of parts”, etc. The task itself was figured out and embedded in its primary resulting document.

The team proceeded to analyse the tasks now from the viewpoint of document management. Discussion started with the scope of the system. It was difficult to drop any of the tasks out because all of them include some document management. The same type of problem arose when analysing the information needs of the job. It was difficult for the team members to assign the needs to a specific job. As a result, the team decided to analyse the needs separately, not associated to any specific jobs.

In the final stage of the analysis, the team paid attention to differentiate between the actual design work and management of the documents of that design. The actual CAD documents are not managed by the current PDM systems at all, but only the metadata of the design document. Attention was given to the integration of the PDM with ERP and other administrative software. The documents of the current ERP system should be handled by the PDM system.

Combination

The final list of requirements worked as the basis for further selection and evaluation of the candidates. However, the list of requirements and the vendors published information did not provide enough information to make the selection. Using multiple criteria in selection was difficult to set beforehand and handle as well. The team also wanted to use the price as a discriminating criterion in order to see how a cheap product competes with expensive ones. This was difficult because more detailed requirements, such as number of users and license type, should be stated before the dealer provides you any information about the price. Moreover, the vendors were unwilling to expose their prices too early.

The team had to modify the predefined criteria and also add new ones. The criteria and weights were checked and modified and some discriminating criteria were dropped. Finally, the selection of the four candidates was made based on the criterion about how the software was integrated into other systems. Moreover, the team wanted to add a new “interesting” candidate to the list (Alpha) even if this was an exception to the COSA process. Gamma was designed to be the standard package to which the other candidates can be compared. Beta was familiar to most of the participants.

Internalization

The power of tacit knowledge appeared when selecting the final candidates. Due to the lack of information, there was not enough explicit information for making the definitive selection based on explicit criteria only. The final selection seemed challenging as well. All four candidates looked good enough and the team members could not actually name any explicit criteria to drop one of them out. Still, one candidate (Delta) was named as being unfit for the company. The grading of candidates by scores resulted in very similar figures (3.00, 2.97, 2.99, 2.88) as well. The Alpha candidate was selected for further testing. Still, the data do not show any explicit criteria for the selection. Alpha was named as being the only candidate, which was independent of any design software packages. The presenter of Alpha was also named as giving the best demonstration and expertise.

General notes

Generally, the team worked very intensively and there were no signs of lack of motivation. However, the team worked only in sessions and not between the sessions. The team followed COSA tasks even though the students did not control the flow of the meeting as expected. However, all participants felt that the team, even if understanding its task well, was slightly unfocussed in the conversations.
3. CONCLUSION

3.1 Findings

The aim of this study was to test how well the team follows the COSA process, how collaboration evolves between the team members and how well the team members are able to perform the COSA tasks.

The team was quite diligent in following the COSA tasks. Collaboration among team members worked very well and the members seem to be committed when involved in a project interlinked with their work. The sessions were also very consensus-oriented and no topic raised any deep discussion or argument between the participants. However, the team did not show much intrinsic (Centers & Bugental 1966) commitment by expressing a joy of the work per sé. However, the project did not require and the participants did not have the time for extra work either.

Orientation towards the work was practical and oriented to existing work context and not on business opportunities. The team was good at analysing work content, but figuring out the total whole in relation to its information needs took time. The analysis of work and its information needs in terms of input, output and stored information, caused problems as well. The work flowed better when the functionalities were discussed separately and not linked to job content.

The list of requirements prepared by the team did not work as making the difference between the candidates. The distinctions between the candidates were not clearly demonstrated. Tacit knowledge became apparent in the selection of the final candidates. Additionally, the final selection was made based on a criterion not included in the list.

3.2 Discussions and Implications to COSA

Elicitation of requirements for the COTS package is a challenging task for users. This study shows that the users cannot find all requirements themselves based on their work content only. This study supports Morisio’s et al. (2000) findings that users should have more time to explore market trends beforehand. As Kato et al (2003) suggests, the requirements determined by the user have to be complemented by the existing software packages as a source of practical domain knowledge. Moreover, the analysis of the requirements and selection of the COTS package can be done together (Maiden and Ncube, 1998).

The need for tacit knowledge was shown to be very important also in the case when the task needed explicit knowledge only. In this study, the users had to make the difference based on earlier defined criteria. Due to the limited hands-on experience with the software candidates, the users could not use the criteria effectively to make the difference between candidates. Real and practical experience also gives food for the “generative dance” of knowledge creation in order to encourage people in constructive discussion about the candidates and requirements.

REFERENCES


ABSTRACT
This study explores which sales best practice business processes are used and carried out with packaged enterprise systems (ESs) by small and medium-sized enterprises (SMEs). The practices of two samples of Greek SMEs, which use two different ESs (ERP, CRM, B2B e-commerce, and business intelligence applications), are qualitatively analyzed from the implementers’ perspective. In several cases, the examined detailed sales subprocesses are not used and/or are not carried out with the ES, even after many years of ES operation. Such deficiencies are observed in sales order and quotation subprocesses, such as customer credit control, product costing, stock availability check, and order confirmation, as well as in sales forecasting and budgeting, CRM, B2B e-commerce, business intelligence, and sales order workflow implementation. The most frequent principal causes of non-use of ES-implemented processes are the lack of knowledge and appropriate structure of the companies, a particular business culture, which prevents best practice process use, and the lack of systematic business rules. An implication of the study is that the examination of the use of detailed processes, in connection with the corresponding ES implementation, should make part of a process and ES use maturity assessment in SMEs.

KEYWORDS
Enterprise information system, ERP system, Business process use deficiency, Sales, SME, Greece

1. INTRODUCTION
This study explores the practices of Greek small and medium-sized enterprises (SMEs) regarding the use of business processes, after the implementation of packaged enterprise information systems (ESs). The ESs which are considered here are ERP systems, supplemented by CRM, e-commerce, and business intelligence (BI) applications.

The use of processes and their ES implementations evolves and matures over time (Markus and Tanis, 2000; Davenport et al., 2004; Lockamy and McCormack, 2004; Hammer, 2007). Several studies reported on the frequency of ES module adoption by companies as an indicator of ES adoption maturity (Spathis and Constantinides, 2003; Davenport et al., 2004; Spathis and Constantinides, 2004; Poulomenakou and Borotis, 2005; Spathis, 2006). ES modules, as for example sales management, can be considered to be high-level processes. However, the previously mentioned studies of Spathis and Constantinides (2003), Davenport et al. (2004), Poulomenakou and Borotis (2005), and Spathis (2006) do not provide data on the ES adoption and use of lower-level processes, i.e., subprocesses, such as for example sales order, and sales order availability check. Spathis and Constantinides (2004) examined the role of ES in the change of accounting processes and reported low adoption rates of several accounting methods, models and processes after ES implementation on a sample of 26 companies - not especially SMEs. Shang and Seddon (2007), Peng and Nunes (2009b), and Pan et al. (2011) provided also examples of ES-implemented process use deficiencies but do not examined thoroughly which processes are used or not used by companies. Doukas and Mantakas (2007) analyzed the use of best practice sales management subprocesses in 19 successful implementations of a single Greek ES in Greek SMEs from the implementer’s perspective and found several deficiencies: Processes which could in principle add value to the companies, are often not used, are not implemented according to best practice, or are carried out without the ES, either manually or with office automation software. However, Doukas and
Mantakas’ (2007) study has several limitations: A small sample of companies using a single ES and a single informer.

The present study, extends Doukas and Mantakas’ (2007) analysis on a second sample of 53 Greek companies, mostly SMEs, which use a second Greek ES, based on the data of a second implementer. The study also provides a revised analysis tool, namely a sales processes reference set and a list of process and ES use deficiencies. The study also updates Doukas and Mantakas’ (2007) results on the initial company sample and provides a dynamic analysis of process adoption. The following basic research questions are addressed:

• RQ1. In successful ES implementations, which best practice business processes are or are not commonly used?
• RQ2. Do companies carry out their processes with their ESs?
• RQ3. In the case where a process is not used or is not carried out with the ES, what are the causes of the non-use deficiencies?

2. RESEARCH METHOD

2.1 Analysis Framework

The analysis of process and ES use is based on Doukas and Mantakas’ (2007) framework, which is summarized in the following. The three basic research questions presented in Introduction can be answered with respect to a reference set of best practice processes relevant to the company activities under consideration, selected by the investigator. The analysis assumes the implementer’s perspective. This allows for considering the use of processes, which can be of potential value for the companies according to the implementer, and which may have not been included in the ES implementation plans of the companies. The ES implementation and use of all the potentially relevant processes of the reference set is assumed to correspond to an optimal company practice indicating a mature use of the ES. This can be thought as an example of ‘Markus and Tanis’ (2000) ES implementation optimal success concept.

The first two research questions allow for a yes/no answer for each process. This evaluation can be essentially objective. However, for some processes, the investigator’s decision on whether a process is relevant and can add value to a company may be subtle. The third research question assumes subjective answers. The implementer’s and company perspectives in particular may differ on this issue.

Three special aspects of the second research question are considered next. Firstly, the posting of process results to the ES is important if these results provide input to other processes. For example, the systematic posting of sales quotations to the ES is important, since quotation historical data can support sales opportunity loss analysis. Sales targets ES posting can support sales progress monitoring. The omission of posting is therefore considered to be a deficiency. Secondly, the use of software other than ES, such as spreadsheets, for carrying out part of a process is not considered to be a deficiency provided that process results are posted to the ES. For example, sales targets can be created using spreadsheets, and results can be next uploaded to the ES. Thirdly, there are ES-enabled processes which cannot be implemented efficiently, if at all, without the ES. In these cases, the first two research questions are connected. Examples are business intelligence processes.

The third research question can be answered by reference to a list of limiting factors of process and ES use or causes of process and ES use deficiencies. An enhanced version of Doukas and Mantakas’ (2007) list is given on Figure 1. The list assumes the implementer’s perspective. The method used for developing this list is stated in Section 2.2. The causes are hierarchically structured. The two major categories relate respectively to organizational issues and the ES. Each deficiency is in general due to multiple causes. The first major category covers process non-use deficiencies, for processes which can be carried out without the ES. The two major categories jointly cover process and ES non-use deficiencies for ES-enabled processes. Finally, the second major category covers ES non-use deficiencies for processes which are carried out without the ES.
1. Causes related to organizational issues
   1.0 Special non-deficient cases
      1.0.1 The process does not apply to company activities
      1.0.2 An alternative process is used
   1.1 Causes related to resource poverty
      1.1.1 Shortage of personnel
      1.1.2 Lack of process-specific know-how
      1.1.3 Lack of tools (other than the ES)
   1.2 The company is not yet mature enough to use the process
      (lack of knowledge / knowledgeable personnel and the necessary supporting structure of the company)
   1.3 The company considers that the process use is not worthwhile or it is counterproductive
   1.4 Business culture of the company
      (practices that do not allow process use, or/and refusal of process potential value)
   1.5 Lack of systematic business rules, inadequate BPR
   1.6 Other cause / unknown cause
2. Causes related to the ES
   2.1 The process is not supported by the ES (too much ES customization is needed)
   2.2 Causes related to ES implementation
      2.2.1 Inadequate ES configuration and/or customization
      2.2.2 Lack of prerequisite processes and data
      2.2.3 Inadequate end user ES training
      2.2.4 End users consider that the process ES implementation is not user friendly
      2.2.5 Inadequate hardware
   2.3 Causes related to ES operation
      2.3.1 Resource poverty in connection with ES use
         2.3.1.1 Shortage of personnel - ES users
         2.3.1.2 Lack of personnel’s basic computer skills
      2.3.2 Negative attitude of personnel regarding ES use
      2.3.3 The company considers that the process ES implementation is not worthwhile or it is counterproductive
      2.3.4 Early post-implementation causes
         2.3.4.1 Inadequate experience in ES-supported process use
            and/or ES potential in general
         2.3.4.2 Inadequate historical data in ES database
   2.4 The company is not yet interested in process ES implementation
      (no other precise reasons known by the informer)

Figure 1. Causes of business process and/or ES use deficiencies

2.2 Research Design

The present study has three main tasks: The creation of a list of causes of process and ES use deficiencies (presented in Section 2.1), a reference set of sales processes, as well as company data collection and analysis. Firstly, the study used Doukas and Mantakas’ (2007) in-depth case study method for reviewing and extending Doukas and Mantakas’ (2007) results. The list of causes of deficiencies and the process reference set were in particular reviewed. Data on the initial sample of 19 Greek SMEs (sample 1) were updated and extended using a long series of interviews, mostly by email and phone, with increasing structure. The informer is the principal ES implementation consultant for all sample 1’s implementations. Data revisions and updates covered the cases of process and ES use and non-use, and the principal causes of non-use deficiencies. Extensions included a dynamic analysis of process adoption. The revised list of causes of process use deficiencies was based on the interviews and was also supplemented by general IT and ES adoption factors, such as those reported by O’Leary (2000), Welsh and White (1981), Laukkanen et al. (2007), Loh and Koh (2004) Shang and Seddon (2007) Peng and Nunes (2009b). The ES and company sample selection criteria were the availability of the informer for a long and demanding collaboration, and the high degree of ES customization and turn-key solution policy of the implementer, which in principle can minimize the probability of ES use deficiencies due to ES and ES implementation deficiencies.

Next, a second sample (sample 2) of 53 Greek companies was selected. It includes 52 SMEs and one big company, which use a second Greek ES. The ES is one of the major Greek ESs with numerous implementations in Greece. The 53 ES implementations were undertaken by a major implementation consulting firm of this ES and cover a Greek town. A single informer, the IT Dept. Head, answered by email a questionnaire, which covered a subset of processes and parameters studied on sample 1.
Both ESs include ERP, CRM, B2B e-commerce, and BI applications. The 71 SMEs follow European Commission’s (2003) SME definition. All the 72 companies have commercial activity. Fifteen sample 1 and 21 sample 2 companies have also manufacturing activity of various types, namely make-to-stock (MTS), make-to-order (MTO), mixed MTS and MTO, and project-based (engineer-to-order).

By the data collection time, sample 1’s companies had used the ES for at least 3 years and 6.5 years on the average, and sample 2’s companies, for at least 3 years and 6 years on the average.

Process use data are qualitatively analyzed.

3. RESULTS

The process reference set and the analysis results by the data collection time are given in Table 1 and discussed in Section 3.1. A dynamic analysis of process adoption is presented in Section 3.2.

The reference set includes sales subprocesses which are in general relevant for SMEs. Processes are hierarchically structured and numbered. For each end-process of the hierarchy and each company sample, the following measures are given: The number of potential users, i.e., the number of companies for which the process is relevant, after having taken into account the special conditions of each company’s activities; the numbers of process users with and without the ES (the latter, for sample 1 only), where ES-enabled processes are marked in the latter column with a non-applicable sign (n/a); the principal causes of two types of deficiencies (for sample 1 only), namely ES non-use deficiencies, and process non-use deficiencies for processes which can be carried out without the ES (in italics, occurring for process 7.2 only) - the identities of the causes correspond to those given in Figure 1, and the number of companies for each cause is given in parentheses, if more than one cause exists; and finally, the average ES-supported process adoption lag after ES going-live, calculated over ES-supported process adopters (for sample 1 only).

3.1 Process Use

3.1.1 Sales Quotation and Order Processing

Sales quotation processing was studied on sample 1 only. All the nineteen companies have sales quotations. Only eleven create quotations using the ES and post them to the ES. The other ones either partially use the ES for data retrieval and processing, and give quotations to customers by phone, or create quotations based on data which are not stored in the ES, and do not post the quotations to the ES.

All the companies use sales orders and post them to the ES. The analysis of sales order processing subprocesses reveals several deficiencies. Four subprocesses were considered: Customer credit control, costing, pricing, and availability check.

Customer credit control evaluates credit risk, categorizes customers, and proposes appropriate payment options for each sales order. Risk evaluation can be based on the Tiresias Greek bank information system, and on aging analysis for old customers. Only one company takes fully-structured ES-supported decisions, based on systematic credit control business rules. All other companies rely on subjective manager decisions. The remaining 18 sample 1 companies have no systematic rules. Only four sample 2 companies use ES historical data for old customer credit control. No sample 2 company posts the reasons of a negative result to the closed sales order, while in many sample 1 cases the sales order is not posted at all.

Twelve sample 1 companies use the ES for calculating and posting order cost. The other sample 1 companies use the ES for displaying the cost per item which has been calculated in advance of the sales order. Posting allows for comparing budgeted and actual costs. Forty-three companies implement their pricing and discount policies using the ES. On sample 1, the cause of the deficiency is the lack of systematic rules.

Gross and net order profit is calculated using the ES by respectively fifty-three and twenty-one companies. The deficiencies for the remaining companies are mainly due to costing deficiencies. Costing models should be adopted and ES-implemented (Mantakas and Doukas, 2012). In twenty-seven companies, salespersons are informed by the ES about offer price acceptability.

Availability check allows for confirming the order’s quantity and delivery date and promising them to the customer. Twenty-one companies calculate the delivery date using the ES, while the other ones set it
empirically. The deficiency was reported on sample 1 to be due to the lack of maturity in the prerequisite forecasting, and inventory planning (purchasing and production planning) processes (Mantakas and Doukas, 2011; Mantakas and Doukas, 2013).

Table 1. Sales process reference set and analysis results (PU: Number of process and ES potential users; ESU: Number of ES users; PrU: Number of process users, where the process is carried out without the ES; APAL: Average process adoption lag after ES going-live)

<table>
<thead>
<tr>
<th>#</th>
<th>Process</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Principal causes of deficiencies</th>
<th>APAL PU ESU ESU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sales quotation processing</td>
<td>19 8 42 11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sales order processing</td>
<td>19 19 100 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sales order processing – subprocesses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Fully-structured customer credit control</td>
<td>19 1 5 18 1.5</td>
<td></td>
<td>4 53 0 0</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Order costing</td>
<td>19 12 63 7 1.5(2), 2.4(5)</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Pricing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.1</td>
<td>Application of pricing and discount policies</td>
<td>19 13 68 6 1.5(5), 2.4(1)</td>
<td>0 53 30 57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.2</td>
<td>Calculation of gross profit per sales order</td>
<td>19 12 63 n/a 2.4</td>
<td>2.9 53 40 75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.3</td>
<td>Calculation of net profit per sales order</td>
<td>19 1 5 n/a 2.2.2 2.9</td>
<td>6 53 20 38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.4</td>
<td>Notification of salesperson by the ES about the acceptability of the order price</td>
<td>19 13 68 n/a 1.2(3), 2.4(3)</td>
<td>3 53 14 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Stock availability check – date calculation</td>
<td>19 2 11 17 2.2.2 2.9</td>
<td>2.5 53 19 36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sales order shipping and billing documents issue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Issue of dispatch note</td>
<td>19 19 100 0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>4.2</td>
<td>Issue of packing list</td>
<td>19 5 26 14 2.4</td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Issue of invoice</td>
<td>19 19 100 0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>4.4</td>
<td>Issue of foreign invoice</td>
<td>12 8 67 4 2.4(3), 1.4(1)</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Sales pricelists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Sales pricelist posting to the ES</td>
<td>15 14 93 1 2.4</td>
<td>0 39 25 64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Update of sales pricelists upon change of purchase price lists</td>
<td>10 10 100 0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Sales forecasting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Sales forecast creation</td>
<td>19 0 0 19 2.2.4</td>
<td>53 53 35 66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>Sales forecast posting to the ES</td>
<td>19 1 5 n/a 1.4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Use of time series analysis</td>
<td>15 0 0 n/a 1.1.2 1.2(2)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sales budgeting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Sales targets creation and posting to the ES</td>
<td>19 2 11 17 2.2.4 and 1.4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Sales monitoring with reference to sales targets</td>
<td>19 2 11 15 2.2.2(15), 1.4(4)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CRM - Sales activities recording and monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>Sales opportunity loss analysis</td>
<td>19 6 32 n/a 1.4(3), 1.2(10)</td>
<td>2.2 53 4 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Sales opportunity loss analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.1</td>
<td>Sales opportunity loss due to stock non-availability</td>
<td>2 2 100 n/a</td>
<td>3.5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9.2</td>
<td>Sales opportunity loss due to competitors' lower price</td>
<td>19 5 26 n/a 2.2.2</td>
<td>2 53 4 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>B2B e-commerce</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.1</td>
<td>Web-enabled sales orders</td>
<td>19 8 42 n/a 1.2</td>
<td>3 53 6 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>Web-enabled balance monitoring by customers</td>
<td>19 8 42 n/a 1.2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Sales order workflow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.1</td>
<td>Sales order workflow</td>
<td>19 1 5 n/a 1.2</td>
<td>3 53 1 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Sales business intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.1</td>
<td>Sales business intelligence</td>
<td>19 13 68 n/a 1.2</td>
<td>2.6 53 12 23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sales opportunity loss due to stock shortage is based on historical data analysis accumulated by stock availability check during quotation processing. It can support corrective tactical decisions of stock replenishment policies. It applies to and is actually used by two sample 1 companies for off-the-shelf commercial goods also available to competitors. This process is not used by any sample 2 companies.

3.1.2 Sales Order Shipping and Billing Documents Issue

The analysis was carried out on sample 1 only. Documents required by law (namely, the delivery note and the invoice or the foreign invoice for domestic deliveries and exports, respectively, and the packing list for
exports) are used by all companies. Delivery notes and domestic invoices are issued using the ES. Packing lists and foreign invoices are issued mostly by text processing software.

3.1.3 Sales Order Workflow

Only two companies have implemented sales order subprocesses as a workflow using the ES, i.e., as successive stages, using systematic and strictly enforced business rules controlling the transition from one stage to the next, minimizing thus human subjective decisions, and using well-defined human roles where a non-automated decision is necessary. The other companies lack the necessary maturity, i.e., knowledge and appropriate structure, for such an advanced process implementation.

3.1.4 Sales Pricelists

Thirty-nine companies, of the fifty-four ones that use sales pricelists, post the pricelists to the ES. ES posting enables price check during quotation and order processing. In commercial activity, sales prices can be updated upon purchase pricelist price update. An automatic update is used by ten sample 1 companies, while the remaining five sample 1 companies have a policy of constant prices over specified time periods.

3.1.5 Sales Forecasting and Budgeting

The following three sales forecasting methods are used by respectively 16, 34, and 5 companies: Ad hoc estimations, percent readjustments of previous year sales, and time series analysis. The first method can be used in cases where no quantitative prediction model exists, as for project-based production. The third method is relatively more advanced.

All sample 1 companies create sales budgets and targets using spreadsheets. Although the ES supports the creation of complex targets along many dimensions, the companies use only a few dimensions and find spreadsheets to be more user-friendly for this purpose. Budget and target uploading to the ES is a simple operation. However, only two companies upload the budget and targets to the ES and monitor sales with respect to the targets using the ES. This deficiency is attributed to the particular business culture of sample1’s companies.

3.1.6 CRM

Ten companies use the CRM application for managing contacts and sales cycles, and monitoring salespeople activities. They also monitor sales opportunity loss due to competitor’s price. Big delays were reported in sales cycle activity data entry on sample 1, especially during travel, due to salesmen’s negative attitude.

3.1.7 B2B Electronic Commerce

Fourteen companies offer their customers web-enabled sales orders. On sample 1, however, it was reported that e-commerce sales represent only a small percentage of the total sales. Eight sample 1 companies offer also balance monitoring processes.

3.1.8 Business Intelligence

Twenty-five companies use BI. Additionally for sample 1, it was reported that there is still a large margin for improvement for BI adopters, which concerns the introduction of more advanced analytics.

3.2 Dynamic Analysis of Process Adoption

Process adoption lag after ES going-live was calculated on sample 1 (Table 1). Processes which yield documents mandatory by law and/or have a long history of computerization, such as the issue of sales order billing and basic shipping documents, are ES implemented by all the companies and were adopted by ES going-live. For the other processes, process and ES use are not universal and/or systematic and lags are observed over the adopter companies.

Additionally, the evolution of ES-supported process adoption after ES going-live was studied on sample 1. A rough measure of process adoption evolution can be given by the percentages of Table 1’s adopted end-processes along time. By ES going-live, the companies have adopted on the average 18.1% of their potentially adoptable processes (minimum 9.5%, maximum 30.4%). By the beginning of the next seven years
after ES going-live, the companies have adopted on the average 7.6%, 0.0%, 0.1%, 2.8%, 1.6%, 0.4%, and 0.0% of their potentially adoptable processes. By the data collection time, as it appears in Table 1, the companies have adopted on the average 30.0% of their potentially adoptable processes (minimum 9.5%, maximum 51.5%). All the companies except one continued to adopt processes in the years following ES going-live. However, average process adoption maturation is rather slow.

4. DISCUSSION AND CONCLUSION

This study aimed at assessing process and ES use maturity, by examining which best practice sales processes are or not used by companies. The study assumed implementer’s perspective, which is external to the companies, and allows for examining the use of processes that may have not be included in the ES implementation plans of the companies, and which are of potential value for the companies according to the implementer. Several sales management subprocesses were individually examined.

The company practices on two samples, using two different Greek ESs, were analyzed based on information provided by the two implementers. The samples include 72 companies in total, of which 71 are SMEs. The results show that several best practice processes of potential value for the companies are not used, or are carried out without the ES. In several cases, process results are not posted to the ES, hampering sales monitoring and the related decision support. In some cases, the ES is used in a loose way, i.e., with no strictly implemented and enforced business rules. Additionally, costing and inventory planning implementation deficiencies affect several sales order processes.

The findings on the second company sample provide support for Doukas and Mantakas’ (2007) conclusions, and for the author’s hypothesis that such ES implementation deficiencies apply in general in SMEs, at least in Greece. The results of ES-implemented process use are qualitatively similar on the two company samples. The two informers also agree on the potential value of process adoption for several non-adopter companies, especially for advanced modules/processes such as e-commerce, CRM, and BI.

Quantitative differences can be also observed between the two samples, such as in sales order net profit calculation, e-commerce, CRM, and BI. However, the study design does not allow for analyzing such differences. Differences may depend on several factors, such as the ES, the company sample, the company size and company culture in particular, the ES implementation practices and policies, the ES implementation budget and effort, and the ES implementer’s modules and process promotion effort.

The dynamic analysis of process adoption on the first company sample suggests that ES use maturation is in general slow and that ES use deficiencies persist several years after ES implementation.

The causes of process and/or ES deficiencies were studied on the first company sample. The three most frequent principal causes are the lack of company maturity, i.e., the lack of process-specific knowledge and company structure, a particular business culture, which prevents companies from using best practice processes, and the lack of systematic business rules which hampers ES implementation.

An implication of the study is that a detailed analysis of process use is in general necessary for evaluating the ES implementation maturity in SMEs. The analysis should precede the measurement of higher-level constructs, such as business process orientation and process and enterprise maturity constructs, for example those of Reijers (2006), Kohlbacher and Gruenwald (2011), and Hammer (2007).

A possible extension could be the study of the influence of the above mentioned factors to ES-supported process adoption and use on a larger company sample. Another extension could be the comparison of the performance between the process adopters and non-adopters. This could provide an experimental testing of the postulated value of best practices.

ACKNOWLEDGEMENT

This research makes part of the BpPractices Subproject of TEI of Epirus Archimedes III Project. It has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF), Research Funding Program Archimedes III - Investing in knowledge society.
REFERENCES


A RISKS-DRIVEN APPROACH TO OUTSOURCING AND REVERSIBILITY IN INFORMATION SYSTEMS

Walid Al-Ahmad1 and Abedallah Al-Oqaili2
1Department of Computer Science - Gulf University for Science & Technology, Kuwait
2Royal Jordanian, Corporate Business Unit, Jordan

ABSTRACT

Failures of IS outsourcing projects have been discussed for several years and many studies concerning outsourcing risk factors have been conducted. However, little work has been done in the area of relating risk factors to the reversibility process, i.e., switching the operations from external vendors back to in-house. There is evidence of sufficient scale to warrant further attention to the reversibility process due to the increased failure of outsourcing projects. One of the main goals of this paper is to provide a risks-driven framework that can be used as a roadmap during outsourcing/reversibility projects. The risks-driven approach to outsourcing and reversibility means that the management decision making process during the outsourcing of the IS should be based on the risk factors that may lead to reversibility. This paper also aims to identify the critical risk factors affecting each stage of the outsourcing process.

KEYWORDS

Outsourcing, reversibility, risk factors, framework, outsourcing lifecycle

1. INTRODUCTION

Outsourcing Information Systems (IS) services is considered a strategic decision for many organizations due to the many risks associated with each step of the outsourcing process. Sometimes a change in a business process requires the organization to carry out an outsourcing project. An example is the paper tickets which were used by all airlines a few years back; now the Air Transportation Associations (IATA) regulations require the use of electronic tickets instead of paper tickets. Outsourcing IS services is a risky endeavor, such as any new product development or capital investment (Aubert et al., 1998). According to the press releases and practitioners, many organizations, in the last 10 years, have changed their strategy and started to consider reversibility as a new strategy. Reversibility can simply be defined as bringing back (in-house) already outsourced IS functions with the goal of rebuilding internal IS capabilities (Hirschheim and Lacity, 1998; Lacity and Willcocks, 2000; Whitten and Leidner, 2006; Overby, 2003; Wong, 2006). Reversibility is considered an exit strategy by organizations due to risks associated with the outsourcing process such as when the relationship with the vendor fails (Wong, 2008).

According to Deloitte Consulting, nearly two-thirds of organizations have already brought some forms of outsourced services back in-house (Samuels, 2005; McLaughlin and Peppard, 2006). Gartner Group reported that 56% of small-sized business and 42% of mid-sized business contracts are considering reversibility following the contract end period (Brown, 2004). Fitzgerald and Willcocks (1998) found that 22% of organizations that prematurely cancelled their contracts chose reversibility. Lacity and Willcocks (2000) reported a higher reversibility rate of 34%. According to a Compass poll of 70 outsourced US companies, only 4% would not consider taking some or all of their IT functions back in-house when their current outsourcing contracts expire. The report published by the Computer Economics web site for the year 2008/2009 showed that 13% of the respondents indicated that back-sourcing was a higher priority (Computer Economics, 2009). These statistics reflect that reversibility became a trend that deserves further attention (Dibbern et al., 2004; Hirschheim and Lacity, 2000; Fowler and Fox, 2006). In fact, reversibility of outsourcing information systems is of great concern to both the organizations and the vendors. The organization should study the implications of its decision of revoking the outsourced function.
Reversibility drivers lie in four categories: Strategic, which includes changes in strategic directions, changes in IT role, changes in organizational structure (due to acquisition, mergers, etc.); Power and politics, which is mainly related to management; Outsourcing expectation gaps, which include cost, service quality, loss of control, IT resources accessibility; Changes in vendor organization like vendor merger with other organizations and vendor bankruptcy (Wong, 2008).

In addition to the risks associated with the outsourcing process, most researches focus on the outsourcing process after the relationship between the vendor and the organization is established; the activities related to pre-outsourcing and post-outsourcing stages are neglected or given little concern albeit they have direct impact on the outsourcing and reversibility processes.

Therefore, there is an increasing need for a framework for outsourcing and reversibility that can be considered as a roadmap for successful implementation of outsourcing projects. Such a framework provides organizations and vendors with a contingency plan for the outsourcing process when outsourcing is to be abandoned. The framework integrates the outsourcing process phase with the pre and post outsourcing phases and identifies the factors that affect each phase.

2. OUTSOURCING RISKS

As with any process, there is a negative side to the outsourcing process of information systems, the disadvantages of outsourcing information systems are considered as the risks associated with the process. These disadvantages are categorized and summarized as follows (Adeleve et al., 2004; Antonucci et al., 1998; Aubert et al., 1998; Bahli & Rivard, 2003; Claver et al., 2002; Dibbern et al., 2004; Earl, 1996; Embleto & Wright, 1998; Gonzalez et al., 2005; Gonzalez et al., 2010; Jae-Nam, et al., 2003; Teng, et al., 1995):

1. Hidden Cost: hidden cost is considered as the biggest information systems outsourcing disadvantages (Lacity et al., 1995), the initial contract cost can be competitive; however, overall cost may significantly be more and includes: transition cost (Cross, 1995; Earl, 1996); management costs (Aubert et al., 1998; Cross, 1995; Earl, 1996); hidden service cost (Lacity et al., 1995).

2. Contractual Difficulties: Contractual management and amendments are often necessary, either because the client's needs are changing, or because most contracts are indeed incomplete (Richard & Seidmann, 1992). Sometimes, requests for changes give rise to disputes, and even litigation. Disputes also occur over the meaning of contractual terms: services to be rendered, service level, personnel expertise, etc. At the time of contract renewal, other difficulties may arise (Aubert et al., 1998). An unsatisfied client may wish to revert back the outsourced function. Yet, they may encounter several difficulties in attempting to do so. Often, the required assets might transfer to the vendor, along with the personnel who possessed the expertise to conduct the outsourced function. In such case, reversibility will be very costly (Richard & Seidmann, 1992).

3. Service Debasement: Service quality and service costs are two major issues in information systems outsourcing. The literature provides numerous examples of degrading service levels resulting from outsourcing like poor response time, poor turnaround time, late updates of software, applications do not meet the requirements, and so on (Aubert et al., 1998).

4. Loss of Organizational Competencies: Outsourcing cedes control to the provider. The very fact that no, or little, IT expertise remains in the organizations is seen as dangerous, since the firm will have lost its ability to use IT efficiently and effectively, and will remain dependent on an external vendor. The ability to align IT with the organization strategy might also be hampered, thus affecting the organizations ability to maintain competitive advantage, and to use IT in an innovative fashion (Subhankar & Bindu, 2006; Earl, 1996; Lacity & Hirschheim, 1993b).

5. Vendor and Organization Knowledge: The level of functional, technological, and managerial knowledge contributes to risks in information systems outsourcing.

6. Cultural Risks: Cultural risks arise from the dominant culture prevalent with the vendor. The attitudes, communication skills, language, team spirit, level of cohesiveness, management style, and related organizational behavioral factors that shape the culture (Subhankar & Bindu, 2006).

7. Political and Financial Risks: Political risks arise out of restrictions imposed by the countries of both parties, type of government, and political and economic stability. Financial risks arise out of project accounting standards, cash flow, asset base, and currency stability.
8. **Company Specific Risks:** Company specific risks are mainly due to organizations financial strength, difficulty in specifying core functions, management, relationships and alliances with other organizations, and potential acquisitions and mergers activities.

9. **Geographic Location:** The country, province, and city may be in different time zones, which require working at odd hours for the organizations or vendor. The communication infrastructure, distance, industrial peace and stability in the region, availability of supporting infrastructure.

10. **Legal Contracts and Intellectual Property:** Intellectual property rights and their legal status in the country, brand protection, intellectual property standards and law vary from one country to another and contribute to risk.

11. **Confidentiality, Security and IP rights Issues:** Security issues are very important and major issues, vendor should provide a clear and written standard procedure which implies not abusing security, security issues includes access control, authentication, data confidentiality, usage of secure protocols, encryption, and security policies adopted by the organizations. Security is also a major concern in global outsourcing as protection and control of data pose a problem.

12. **Disaster Recovery:** Ability to protect software code, related data, level of replication, redundancy and back-up and recovery policies are the main factors in deciding the risks due to disasters. Loss of control over disaster recovery contributes to risk.

13. **Staff Morale:** Severe cuts in staff damages the morale of existing workers and may encourage the most talented and marketable staff to seek opportunities elsewhere, also employee lay-offs is not beneficial to the organization public image especially in large firms.

14. **Risk of Continuity:** Continuity of service may be jeopardized because of the transition between contractors, higher employee turnover, or contractor bankruptcies.

15. **Loss of Flexibility:** Most outsourcing vendors require long-term contracts that provide them with stable revenues. Contracts must be negotiated to allow variability in demand and cost, this flexibility comes with additional cost.

16. **Loss of In-house Expertise:** affects the ability of the organizations to provide services in the future if the contract terminated or vendor bankruptcies or the organization decide to consider reversibility.

3. **OUTSOURCING AND REVERSIBILITY FRAMEWORK**

In this section, we present the framework that describes the outsourcing and reversibility in terms of tasks and key factors affecting them. The proposed framework can be used by organizations to successfully implement outsourcing and reversibility projects if the necessary actions have been taken to avoid or alleviate the risks. Although the risks discussed in the literature are usually described in general terms/forms, they are identified in this model as low-level risks, i.e., they represent the root causes of the general categories of risks. The framework divides the process into three stages, namely Pre-Outsourcing Stage, Outsourcing Implementation Stage, and Post Outsourcing Stage. Also each stage is divided into three steps: Analysis, Design and Implementation. In each of these steps, the framework specifies the factors that affect the outsourcing and reversibility processes. The identified factors will be used to provide evidence and find the level of divergence between the literature results and the outsourcing process in the practice. Organizations can benefit from this framework by considering the factors that affect reversibility while they are building the outsourcing relationship. If these factors are not considered from the beginning, it will be hard and costly for an organization to exit the relationship and reverse the functionalities back in-house.

3.1 **Pre-Outsourcing Stage**

The pre-outsourcing stage is concerned with the organization’s outsourcing decisions. It focuses on the factors to be considered by organizations when they go for outsourcing as well as the factors that affect the reversibility process when such a decision is made by the organization, at any time after the outsourcing process is started. The analysis phase focuses on the steps needed to translate the inputs into tasks and identifies, based on these tasks, the factors affecting the outsourcing and reversibility process. The design phase focuses on the steps to be considered by organizations in order to implement the tasks specified in the analysis phase and again identify the factors affecting the outsourcing and reversibility process. The
implementation phase focuses on the factors affecting the outsourcing and reversibility process as a result of implementing the decisions taken during the design phase of the pre-outsourcing process.

3.1.1 Pre-Outsourcing Stage – Analysis Phase

The analysis phase includes two major steps. During the first step, the organization should clearly specify its outsourcing strategy (King, 2001). The goals and objectives of outsourcing and types of outsourcing the organization is looking for should be stated clearly. During the second step, the project is initiated which marks the start of the outsourcing or reversibility project. The team responsible for carrying out the tasks and a steering committee responsible for controlling and following up the whole project are created (Wideman, 1986). Table 1 summarizes the key factors to be considered during the analysis phase. Due to limitation in space, the factors are not explained in the article; for more discussions on them, please consult the references.

Table 1. Pre-Outsourcing Stage – Analysis - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outsourcing Objectives</td>
<td>Focus on core competences; Cost reduction; Lack of resources; Service level</td>
</tr>
<tr>
<td></td>
<td>improvement; Migration to new technology</td>
</tr>
<tr>
<td>Outsourcing Strategy Types</td>
<td>Offshore/ inshore outsourcing; Selective outsourcing; Business process outsourcing;</td>
</tr>
<tr>
<td></td>
<td>Joint venture outsourcing; Build-Operate-Transfer outsourcing</td>
</tr>
<tr>
<td>Project Initiation and Team Building</td>
<td>Project announcement; Team domain knowledge; Team experience in outsourcing;</td>
</tr>
<tr>
<td></td>
<td>Team support &amp; resources</td>
</tr>
</tbody>
</table>

3.1.2 Pre-Outsourcing Stage – Design Phase

The design phase consists of five major steps: 1) the organization project team should assure the organization readiness for outsourcing; 2) the project team should create a concise request for information (RFI), request for proposal (RFP), and request for quotation (RFQ); 3) the project team should create the decision criteria; 4) the project team should agree on the vendor selection criteria; 5) vendor selection (Koh et al., 1999; Webb and Laborde, 2005; Michell and Fitzgerald, 1997).

Table 2. Pre-Outsourcing Stage – Design - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization Readiness</td>
<td>Applying software methodology; Requirements and specifications; Security</td>
</tr>
<tr>
<td></td>
<td>and intellectual property; Budget; Type of project &amp; project duration; Data</td>
</tr>
<tr>
<td></td>
<td>migration</td>
</tr>
<tr>
<td>Request for Proposal</td>
<td>Vendor selection for RFI; Knowledge in creating RFP; Creation of concise response</td>
</tr>
<tr>
<td></td>
<td>criteria; Vendor profile information; Vendor evaluation criteria</td>
</tr>
</tbody>
</table>

3.1.3 Pre-Outsourcing Stage – Implementation Phase

The output of the design phase of the pre-outsourcing stage is a shortlist of vendors. The selection is mainly based on the vendor records and the functionality provided. The implementation phase will focus on selecting the best vendor from the shortlist based on rates provided by vendor, negotiated prices, and sign contract and service level agreements (SLA) (Michell and Fitzgerald, 1997). Table 3 summarizes the key factors.

Table 3. Pre-Outsourcing Stage – Implementation - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Price Negotiation</td>
<td>Price (Initial, installation, support, currency, per diem, hotels, etc…);</td>
</tr>
<tr>
<td></td>
<td>Payment strategy; Taxes, inflation, penalties</td>
</tr>
<tr>
<td>Contract Key Terms</td>
<td>Scope of contract/service; Performance standards; Pricing (releases, support);</td>
</tr>
<tr>
<td></td>
<td>Management and control; Transition requirements; Termination provision; Contract</td>
</tr>
<tr>
<td></td>
<td>duration and modifications; Security, audit and IP rights; Legal issues (Force</td>
</tr>
<tr>
<td></td>
<td>Majeure, Governing Low, Dispute resolution and escrow agreements); Support and</td>
</tr>
<tr>
<td></td>
<td>maintenance standards; Deliverables, vendor team</td>
</tr>
</tbody>
</table>

3.2 Outsourcing Implementation Stage

The outsourcing implementation stage is a shared project between the organization and the vendor. The implementation stage deals with the tasks to be carried out by each party in order to have a successful
implementation of the outsourced IS. This stage involves the start-up activities of planning the transition and implementation of the outsourced agreement as well as establishing the detailed budget and administrative functions needed for its management, and formally launching of the project. The output of the pre-outsourcing stage (contract and project) forms the input of the implementation stage. The contract and project include many risks that need to be managed carefully in order to achieve the desired objectives of the outsourced IS. The analysis phase focuses on how the project leaders of both parties will carry out the project starting from the kick-off meeting to the development of the project plan. The design phase focuses on the steps to be considered by the organization and vendor to make sure that the project plan will be implemented according to the specified time, resources and cost. It includes finalizing the gap analysis and signing final specification and requirements documents, preparations required, identifying each party responsibilities, developing a migration plan, a testing plan, and developing monitoring templates. The implementation phase focuses on the installation of the developed outsourced system, examining the documents delivered by the vendor and the cutover preparation. All these tasks should be carried out according to the signed agreements between both parties. The output of this stage will be the developed IS and the signed SLA.

3.2.1 Outsourcing Implementation Stage – Analysis Phase

The analysis phase includes two major steps: scope and planning of the project and the development of the initial project plan to be followed during the project.

Table 4. Outsourcing Stage – Analysis - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope Planning</td>
<td>Kick-off meeting; Gap analysis; Project requirements;</td>
</tr>
<tr>
<td></td>
<td>Communications lines; Country restrictions</td>
</tr>
<tr>
<td>Project Plan Management</td>
<td>Tasks list &amp; prioritization; Estimation of resources;</td>
</tr>
<tr>
<td></td>
<td>Estimation of time duration; Developing schedule</td>
</tr>
</tbody>
</table>

3.2.2 Outsourcing Implementation Stage – Design Phase

The design phase concentrates on three major issues: controlling project schedule and budget by the organization team; creating a monitoring plan with the vendor; developing training, test and migration plans.

Table 5. Outsourcing Stage – Design - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlling Project Schedule</td>
<td>Agreement on final specification; Approving project</td>
</tr>
<tr>
<td></td>
<td>schedule; Examining organization readiness for</td>
</tr>
<tr>
<td></td>
<td>implementation.</td>
</tr>
<tr>
<td>Developing Monitoring Plan</td>
<td>Controlling schedule; Controlling project cost and</td>
</tr>
<tr>
<td></td>
<td>budget; Controlling &amp; monitoring risks</td>
</tr>
</tbody>
</table>

3.2.3 Outsourcing Implementation Stage – Implementation Phase

The first factor in the implementation phase is developing an installation plan. An installation plan can be created either by the vendor or by the organization with the vendor’s direction. This depends on how the agreement is built. The system could be hosted at the vendor’s premises, and in this case the vendor should carry out the installation. If the system is hosted at the organization’s premises on the other hand, then it becomes the organization’s responsibility to carry out the installation. Finally, the installation could be carried out by both parties. The installation plan should specify the size of the database, disk space required and the system architecture.

The training plan should be developed by the vendor and should cover all the system modules and all activities inside each module. The type of training (train the trainer or train all users) should be specified as well. This also depends on the project size, number of staff to be trained, number of modules, and the system complexity. Also, the staff and vendor communication and language skills, duration, location of the training should be specified, among other things.

The testing plan should be provided by vendor and carried out by the organization team who should deeply test each single activity to ensure that the functionality is provided as needed and documented in the specifications. The test plan should include different test methodologies (unit test, module test and system test, integration and interfacing tests). During the test plan, the users should log and notify the vendor team with any unexpected outputs, errors, and bugs to be fixed before moving to production. The testing phase usually
ends up by signing the user acceptance test letter (UAT), which indicates that the IS conforms to the desired functionalities and agreed upon specifications.

The migration plan is of great importance for outsourcing and reversibility. Such a plan is important when the system is already built and having the information on a database or spreadsheets. The migration plan can start at an early stage during phase two; the vendor should specify the minimal required information by the system, and should provide templates to be used by the organization team who should provide the information according to the specified templates. The migration plan usually includes routines and application program interfaces (API). These API's should be tested to ensure that all the provided information is correct, no conflicts in the data exist, and the API's are running smoothly. The vendor migration templates should specify which of the items are mandatory and which are optional. Also it should specify the data types of each element and its length, the starting and ending position of each element, the template format (text files, spreadsheet, etc...). Finally, system documentations should be received and reviewed by the organization team; it should include all required documentations, analysis and design documents, database documentations, system integration and system interfacing documents. System documentation is of high importance for the outsourced project and its possible reversibility. The output of the implementation stage is the developed IS. Usually an SLA is signed with the vendor for the project support and enhancements.

Table 6. Outsourcing Stage – Implementation - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing Transition Plans</td>
<td>Developing installation plan; Developing training plan; Developing testing plan; Developing migration plan; Cutover requirements; Reviewing system documentation; Developing installation plan</td>
</tr>
</tbody>
</table>

3.3 Post Outsourcing Stage

The post outsourcing stage is a major stage which focuses on controlling and auditing the delivered IS. This stage actually is highly related and dependent on the previous two stages since auditing and controlling should take place almost during all the steps discussed in the previous stages.

3.3.1 Post Outsourcing Stage – Analysis Phase

The analysis phase in the post outsourcing stage is the most important one in the framework. Based on the results of this phase, the organization decides to stay with the vendor, look for a different vendor, or consider reversibility. In this phase, re-evaluation of the whole process in the analysis phase should take place. The organization management and project team should assess and monitor the whole process, revisit all the steps and processes, specify the strength and weaknesses, boost the strength and address the weaknesses by implementing a SWOT analysis and enhancing the work around solutions and shortcuts.

The framework specifies three steps to be considered and deeply investigated. These three steps are: monitoring and evaluating the delivered information system; evaluating and managing contract and vendor; evaluating and managing the organization staffs who work on the delivered product.

Table 7. Post-Outsourcing Stage – Analysis - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring/Evaluating Delivered Product</td>
<td>Checking results against objectives</td>
</tr>
<tr>
<td></td>
<td>Monitoring performance and other quality factors</td>
</tr>
<tr>
<td>Evaluating/Managing Contract and Vendor</td>
<td>Controlling payments, support, change requests</td>
</tr>
<tr>
<td></td>
<td>Controlling vendor commitment</td>
</tr>
<tr>
<td>Evaluating/Managing Users</td>
<td>Employing right staff and right skills</td>
</tr>
<tr>
<td></td>
<td>Building trust and experience</td>
</tr>
</tbody>
</table>

3.3.2 Post Outsourcing Stage – Design Phase

The post outsourcing design phase focuses on how the organization is going to monitor, evaluate and manage the key issues explained previously in the analysis phase. This implies the use of metrics and standard measurements, using tools that help in measuring and facilitating the success of the outsourced IS, and investing in organization staff and governing the relationship with the vendor.
Table 8. Post-Outsourcing Stage – Design - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issues to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applying Standard Metrics</td>
<td>Business value and productivity change; Customer satisfaction; Quality (performance, reliability,..)</td>
</tr>
<tr>
<td>Auditing</td>
<td>Validation and verification testing; Software stability; Intellectual property, data security and control; Vendor commitment to SLA; Classifying/logging problems</td>
</tr>
<tr>
<td>Investing in Users</td>
<td>Encouraging users; Solving problems; Change management and procedure; Training, staff morale,..</td>
</tr>
<tr>
<td>Governing Relationships</td>
<td>Focusing on win-win relationships; Incentives and penalties; Communication and understanding culture differences</td>
</tr>
</tbody>
</table>

3.3.3 Post Outsourcing Stage – Implementation Phase

Based on the results of monitoring, managing and applied metrics, the organization should re-evaluate its position in outsourcing. The organizations in this phase should reach a point to set a clear and concise contingency plan, as well as to continue in the iterative process of the previously explained steps in the analysis and design phase.

Table 9. Post-Outsourcing Stage – Implementation - Key Factors.

<table>
<thead>
<tr>
<th>Key Factors</th>
<th>Issue to Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency Plan</td>
<td>Exit or continue Plan with vendor; Data migration plan; Documentation and data warehouses</td>
</tr>
<tr>
<td>Periodical Reviews and Meetings</td>
<td>Day to day and scheduled meetings; Site visit to monitor vendor conditions</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Outsourcing and reversibility practices have led to success and failure stories. Many researches have addressed outsourcing and reversibility as opposite phenomena. This article addressed the issues concerning the outsourcing and reversibility using a single framework. The framework divides the outsourcing/reversibility process into three stages, each of which is divided into three main steps. Each step is explored and investigated through an explanatory study of the literature concerning the major factors to be considered by organizations when implementing an outsourcing or reversibility project. The framework introduced the key factors to be considered in each stage of the outsourcing/reversibility process in order to achieve a successful outsourcing/reversibility. As a future work, the framework will be applied in some organization to test its effectiveness. Also, a taxonomy of the risk factors from the client and the provider viewpoints will be created.

REFERENCES


BPM, OPEN SOURCE AND SOA -- MISSION IMPOSSIBLE?

Martin Schöpple, Philipp Brune and Heiko Gewald

University of Applied Sciences Neu-Ulm - Wileystraße 1, D-89231 Neu-Ulm, Germany

ABSTRACT

Business Process Management (BPM) promises to improve alignment between IT and business processes. In recent years, web services and service-oriented architectures (SOA) have been intensively discussed as paradigm for IS architectures designed to enable BPM. However, since SOA is not precisely defined, little is known about its actual real-world adoption and how it can be successfully implemented. Since many SOA concepts are based on open standards, open source software (OSS) seems a natural choice for SOA implementation. To foster the discussion whether a SOA may be purely based on OSS tools, this paper presents a proof of concept implementation of a realistic core business process. The feasibility of using OSS for SOA and of commonly accepted general SOA principles are analyzed and critically discussed. The results demonstrate that many SOA concepts lead to a more efficient IS architecture only if they are used carefully and well-tailored to the actual requirements.

KEYWORDS


1. INTRODUCTION

In recent years, service-oriented architectures (SOA) are amongst the most intensively discussed topics in business information systems engineering research (Hirschheim et al., 2010, Welke et al., 2011). Usually, SOA is understood as an enterprise architecture style designed to enable business process management (BPM). SOA are based on loose coupling of distributed, independent, encapsulated functional units referred to as services (denoting software components as well as organizational or business units), flexibly combined and orchestrated by a workflow engine (enterprise service bus, ESB) to form the business processes (Josuttis, 2008). The common vision is that service orchestration may be performed by graphical process modeling without the classical development tasks (i.e. writing program code) thus allowing for closer and more agile business-IT alignment (Varadan et al., 2008). In general, SOA are not a pure IT but also an organizational or managerial concept. Thus, considerable amount of research examines SOA and specifically its organizational implications (Joachim, 2011). Despite SOA are in principle not related to any actual implementation technologies for the services and the ESB, it is commonly assumed that services and service orchestration are based on popular Web-Service standards and technologies (like e.g. SOAP, REST, WSDL, WS-BPEL, BPMN) (Josuttis, 2008). The latter, more narrow understanding of a SOA, frequently adopted by software vendors and application developers, is referred to as Web-Service-oriented Architecture (WSOA) in this paper.

While WSOA concepts have been successfully used for integrating heterogeneous enterprise applications and modularizing existing (legacy) applications for many years (Schmidtman, 2005), it still remains an open question if and under which conditions WSOA are really feasible as an architectural style for building entire enterprise IT architectures, enabling businesses to successfully replace the traditional complex monolithic enterprise applications (like ERP and CRM systems) with a more flexible solution. Despite that it has been claimed that this kind of SOA is dead (Manes, 2009), a systematic study of the implications of actually constructing an enterprise-wide IT infrastructure by means of a WSOA is still lacking. In addition, for lowering the entrance barrier to WSOA adoption, the possibility to implement it using open standards and stable and efficient Open Source Software (OSS) tools and components is considered crucial, since both are well-established and commonly used in traditional software development.
This paper analyses whether it is possible to implement a pure WSOA using only Open Source Software (OSS). A commonly known real life business process (online ordering) was chosen to serve as proof of concept-implementation. The feasibility such a WSOA and its impacts on information systems development regarding development tools, maintainability, security and performance are analyzed and discussed and critical issues explicated. The paper closes with guidance for further research and the conclusion.

2. REVIEW OF THE LITERATURE

The information systems literature provides a vast variety of topics in SOA related articles. Academic research covers the whole spectrum from the management perspective (cost/benefit analysis etc.) to technical implementation details. The same holds true for Open Source Software, which received a great deal of attention in the last years. It seems like an obvious case to combine these two immensely rich re-search streams to identify the opportunities OSS offers for implementing SOA. Contrary to the authors' expectations, the publicly available body of literature is surprisingly small when it comes to merging these two closely related areas.

2.1 Business Value of SOA

SOA is a topic which has long been discussed as the new hot thing in information technology and systems development. Up to today the discussion is ongoing. Welke et al. (Welke et al., 2011) and Hirschheim et al. (Hirschheim et al., 2010) provide contemporary and comprehensive overviews on the business and IT related drivers for implementing SOA. They name "reusability" as the number one factor for adopting SOA. To assess the organizational readiness for implementing SOA and address the issue of differences in readiness perception between business and IT they provide a CMMI-like maturity model. In conclusion they support the overall benefits of SOA and support the case for further research in this area.

2.2 Business Process Management (BPM) and SOA

"Business Process Management and Service Oriented Architectures are considered a powerful combination for supporting enterprise’s success" (Adam and Doerr, 2008). Even though this claim stands widely undisputed in current information systems research, we hardly see any published material on how this combination is actually being set to work in practice. We see a lot of research supporting the different advantages SOA offers in combination with BPM and we also see authors proposing frameworks how to tackle the most common problems in SOA implementation.

Varadan et al. (Varadan et al., 2008) for example argue for the strong advantages of SOA to increase business process flexibility. Joachim et al. (Joachim, 2011) argue in the same vain and provide an empirically tested alternative research model for SOA governance.

The convergence of BPM and SOA is also supported by several authors e.g. Leyking et al. (Leyking et al., 2007) or Draheim (Draheim, 2010). Draheim provides an in-depth evolutionary overview of SOA and demonstrates how BPM and SOA con-vero\-ged in the course of latter years. He also points out the difficulties and limitations for actually implementing such a converged environment in real life situations.

2.3 Open Source SOA

The majority of publications address the opportunities to build an SOA with OSS either from a conceptual point of view or report case studies. Wieland (Wieland, 2007) gives an overview on OSS tools for SOA development and discusses different business models on OSS environments including the respective implications of differ-ent licensing agreements.

Viering et al. (Viering et al., 2009) conduct a literature review on SOA and identify 175 papers for further examination. Although they created a specific category on implementation patterns ("How are SOA and web services adopted in practice?") they found a number on case studies on SOA implementation (mainly from...
the financial services sector (see e.g. (Baskerville et al., 2010), pp. 30–53) but did not report findings on SOA with OSS.

One of the rare cases of developing a software that comprises real life business cases in a SOA concept using OSS is documented by Siebenhaar et al. (Siebenhaar et al., 2008). As this is the actual documentation of a study project his emphasis is more on comparing different approaches the respective teams used as to the question whether OSS tools are mature enough to replace commercial software for such developments.

Altogether, authors unanimously acknowledge the value of SOA and as such foster research on this topic. Various authors also underline the demand for OSS tools to be used to develop SOA/BPM (e.g. (Wieland, 2007), pp.1–5). However, an actual documented proof of concept, to analyze whether it is possible to build an SOA based exclusively on OSS tools is still outstanding.

2.4 Research Gap

In conclusion the vast majority of authors expect superior business value to be gained through service oriented architectures, especially when intelligently combined with a business process management layer. However there are still some issues unsolved mainly on organizational level and specifically on SOA governance.

Although we find rich streams of publication in different areas of SOA and BPM implementation we identify a huge gap when it comes to actual implementation of these concepts in practice. Apart from some cases predominantly in the financial services industry we hardly find documented experiences examining how actual SOA/BPM implementations look like and what insights can be drawn from these implementations. Furthermore another big trend in information systems -namely the use of open source software- has widely been neglected in this context.

As OSS increasingly finds its way into professional environments the question "Is it possible to implement a real life business process based on SOA principles with just using OSS tools?" becomes ever more important to researchers and practitioners alike. This paper provides an answer to this question by examining a proof of concept for a real life business process which is implemented using only OSS tools.

3. BASIC SOA AND WSOA CONCEPTS AND TOOLS

The main architectural concepts of SOA and WSOA are loose coupling, the use of an ESB and the use of (web) services. Loose coupling is a fundamental concept of software architecture and goes far beyond the different elements of a SOA. It aims at the minimization of dependencies and cohesion between different software components. The ESB realizes this principle consequently at the infrastructure level and enforces the independence as well as the interoperability of processes and services. It usually offers a service registry to manage existing services in the enterprise, security support functionality and a workflow engine to execute business processes by calling services. A service in this sense is as a software component with a standardized, open interface offering a well defined business functionality. It enables users as well as other applications and services to use this business functionality in a technology-neutral and platform-independent way, locally or via network. Services may be flexibly combined to form business processes, are reusable and support loose coupling of the different components (Josuttis, 2008, Melzer, 2008).

In context of a WSOA, services are implemented as web services. Their biggest advantage is the use of standardized web protocols like HTTP for invoking service operations. Therefore, they can be easily integrated in existing IT infrastructures and can be invoked by every web capable device (Daum, 2005). The four most important standards regarding web services are the Web-Service Description Language (WSDL), a XML format used to describe the external interface of a service, the XML message format SOAP used to invoke service operations, the directory service UDDI and the Web-Service Business Process Execution Language (WS-BPEL), an XML format used to model and execute business processes based on web services (Josuttis, 2008).

When the proof of concept implementation was started, the available open source tools and components were evaluated and the most promising tools were selected based on criteria such as offered functionality, stability, performance, development activity and project and community support. Some components have been updated in the meantime or were being replaced by alternative technologies (such as exporting stateless
session beans as web services in EJB 3) (Goncalves, 2009). However, these updates do not significantly affect the results of this study.

3.1 Apache Axis2

Apache Axis2 (http://axis.apache.org) is a Java framework for implementing web services using the SOAP protocol (versions 1.1 and 1.2) as defined by the W3C (http://www.w3c.org) as well as the popular REST (REpresentational State Transfer) pattern and serves as a runtime environment for such web services. Thereby, the interaction with the web service implementation takes place via an object model which primarily mimics the structure of the corresponding WSDL 2.0 file. For XML processing, Axis2 uses its own object model called AXIOM (Axis Object Model) which is based on the streaming API for XML (SAX, http://jcp.org/aboutJava/communityprocess/final/jsr173/index.html) and increases the memory-efficiency notably compared to other document models like Document Object Model (DOM). The functionality of Axis2 can be extended by so called modules. A module can mount itself at any point in the message handling process inside the engine and conduct changes to the in- and outgoing messages. This makes it possible to later extend Axis2 by any WS-* standard like e.g. WS-Security.

3.2 Enterprise Service Bus (ESB)

At the heart of any WSOA an ESB is required for executing the business processes. Therefore, the selection of an appropriate open source ESB forms the basis the proof-of-concept implementation. For building up a WSOA the selected components were required to support all the web service related WS-* standards, in particular WS-BPEL. This lead to the exclusion of the popular Mule ESB (http://www.mulesoft.org), which does not support BPEL processes by default. Due to unclear perspectives regarding development activity and community support, also OpenESB (aka GlassfishESB) was discarded (http://wiki.open-esb.java.net). Finally, the well supported Apache ODE (Orchestration Director Engine) in combination with the Apache ServiceMix ESB was finally selected.

Apache ODE is an open source, BPEL-capable workflow engine developed by the Apache Software Foundation (http://ode.apache.org). It enables the execution of business processes in a WSOA.

3.3 Development Tools

Eclipse (http://www.eclipse.org) is one of the most popular integrated development environments (IDE). Starting with version 3.0, Eclipse itself forms only the core framework, while the actual functionality is provided by numerous plug-ins. Today, Eclipse offers plug-ins for different programming languages as well as nearly every other purpose. Also for WSOA development various useful extensions are available. In the present study, Eclipse IDE 3.5 (Galileo) for Java EE Developers was used. The most important extension in combination with Axis2 are the Apache Axis2 Tools for Eclipse.

NetBeans IDE (http://www.netbeans.org) is a Java-based, open source integrated development environment originally developed by Sun Microsystems for Java developers. Like Eclipse, also NetBeans today supports further programming languages and its functionality may be extended using plug-ins and so-called packs. In the present work, NetBeans IDE 6.7 was used. NetBeans was used in addition to Eclipse due to its powerful and well designed BPEL designer. The latter is part of the Service-oriented Architecture Project (http://soa.netbeans.org/soa/), which provides different modules for NetBeans supporting SOA development. However, this project seems not to be continued further and NetBeans 6.5 was the last release explicitly supported by it.

Only recently, the new open source BPEL Designer plugin V1.0 for the Eclipse IDE has been released (http://www.eclipse.org/bpel/). While the BPEL processes as shown in this paper originally were designed using the NetBeans BPEL designer, the authors evaluated the new Eclipse BPEL Designer by re-modeling these processes partially. The functionality and the graphical WS-BPEL editor of the new Eclipse plugin were found to be comparable to the former NetBeans BPEL designer. Thus, the conclusions drawn below from regarding the BPEL modeling remain valid when using the new Eclipse plugin instead.

soapUI (http://www.soapui.org) is an open source software tool for testing web services. The software is written in Java. soapUI i.e. allows the invocation and inspection of web services using the imported WSDL
file. Moreover, it offers additional functionality for performing different performance and functional tests of web services. In the present work soapUI version 3.0.1 was used.

4. PROOF OF CONCEPT STUDY

4.1 Example Process

In order to validate the feasibility of a WSOA architecture, first a typical and realistic business process had to be selected. We decided for a simplified customer order process like it is commonly implemented in Enterprise Resource Planning systems. Fig. 1 depicts the process as event-driven process chain diagram.

![Diagram of simplified customer order process]

Figure 1. Simplified customer order process.

To execute its business functions, this process requires different basic services implementing the core tasks of customer, materials and order management. In the examined WSOA these services have been implemented as SOAP-based web-services in Java using the Apache Axis2 engine. In the following, German
names of certain components are provided in brackets as far as necessary, since the actual proof of concept implementation was done in German language.

4.2 Basic Web Services

Basically there are two possible approaches of developing web services, namely the top-down and the bottom-up approach. In the former, the interface of the web service is developed first in form of a WSDL document, from which the required service Java classes are generated afterwards. The latter starts by first implementing all web service functionality e.g. as Java classes and generating the corresponding WSDL file afterwards from these classes. This is especially useful for converting legacy code into web-services. The Axis2 tools for Eclipse support both variants and allow the generation of the respective missing parts. For the present study, the customer service (KundeService), order management service (BestellungenService) and materials management service (LagerService) have been developed using the top-down approach, each storing its respective data independently in its own relational database and providing at least the respective CRUD (create, retrieve, update, delete) operations in the service interface.

4.3 WS-BPEL Processes

Combining the above web services, the business process illustrated in Fig. 1 was implemented by two executable WS-BPEL processes and deployed to the Apache ODE workflow engine. In the present study, the two processes are used, namely the ordering service (BestellService) and the materials processing service (LagerProzessService). The ordering service forms the main part of the process implementation and orchestrates the other web services and processes. It is intended to be called by a client application to perform a customer order.

The ordering service process invokes the materials processing service to obtain the material records for the ordered materials. The materials processing service executes a WS-BPEL process that basically encapsulates the materials management service and allows its asynchronous invocation. Its purpose is to examine also asynchronous process invocation and so to improve the overall performance and load balancing.

The realized processes are based on the BPEL Version 2.0 as specified by OASIS. The NetBeans IDE 6.7 with the BPEL-Designer Plug-In was used as the development environment. The processes were run in Apache ODE 1.3.3 deployed in Apache Tomcat 6.0.24. The Java Runtime Environment was Java Version $1.6.0_17$ under Mac OS X Version 10.6.2.

4.4 Results

The evaluation of the described realistic proof of concept implementation of a WSOA allowed to study in detail all implications of such an IS architecture, especially regarding development and performance. In addition, it revealed important insights regarding the feasibility of WSOA in general and especially its realization using OSS.

First, it can be clearly stated that it is in principle possible to build a working WSOA purely from OSS components. Also for implementing common security standards or a web service SSO and the integration with enterprise-wide identity management solutions (like i.e. directory services) suitable OSS solutions exist.

However, regarding the feasibility and the actual benefits of a WSOA in general, it became obvious that the overall performance and the computer resource consumption of a WSOA implementation is orders of magnitudes higher compared to the traditional architectural pattern of monolithic applications. Within the proof of concept implementation, even a single workflow instance of the order process runs about 5s on standard hardware (Intel Core 2 Duo, 2.1 GHz, 2.5 GB RAM) without further workload on the machine. An alternative implementation of the same process inside a monolithic application using i.e. Java EE (Backschat et al., 2007) on the same hardware would need less than 1s. This time lag is due to the WSOA protocol overheads (SOAP, http, WS-Security, etc.) and the necessary XML generation and parsing and in agreement with results from other studies (Tertilt, 2011). Thus, the functional granularity of the web service operations is crucial for the overall performance. Web service operations corresponding to individual business process functions (or tasks) like in the presented proof of concept in general proved to be too small to achieve a
reasonable performance compared to monolithic applications. Thus, it became obvious that specifying the right-sized service operations is the key success factor.

In addition, the loose coupling approach of WSOA requires implementation of distributed transactions in WS-BPEL by means of optimistic transaction processing using compensation handlers in case of a rollback. This significantly increases the modeling complexity as well as further affects the performance compared to transaction monitors like CICS or Java JTA-compliant application servers in traditional monolithic applications (Backschat et al., 2007, Goncalves, 2009).

Regarding software development in a WSOA, the approach basically replaces the programming of processes and business rules in high-level programming languages (like i.e. Cobol or Java) with their well established and elaborated development and debugging tool support (like i.e. Eclipse IDE) by graphical process models. The latter are represented as XML documents with still comparably poor OSS development tool support (regarding i.e. debugging and testing). In many cases, additional handcoding of XML was necessary. Commercially available tools (like i.e. Intalio BPM suite) seem to provide a significant improvement, however are not licensed as OSS. Thus, the two main challenges regarding the use of SOA as a means of BPM turned out to be the transition from the graphical process models to the executable WS-BPEL and WSDL documents, which still requires manual effort and is poorly supported by the development tools, especially those from the OSS domain. Second, regarding the functional granularity of the service operations, the desired flexibility by using small functional units to support BPM is contradicted by their high performance impact. So designing adequate services is the most crucial issue, requiring a suitable compromise regarding their functional granularity.

5. CONCLUSION

In conclusion, this paper presented a proof of concept implementation of a realistic business process to validate the concepts of a web service-oriented architecture (WSOA) for enterprise IS implementation and the feasibility of its realization with open source software (OSS). While the realization with OSS proved to be in principle feasible, the evaluation of the described proof of concept implementation revealed some critical key issues that need to be taken seriously when implementing a WSOA to support BPM. Namely, the functional granularity of the service operations showed to be crucial for the performance and efficiency of the implementation, while it is also important for the flexibility regarding BPM.

Further research is needed to empirically study service development and determine best practices and methodologies to specify, design and implement services of adequate functionality regarding performance and flexibility. In addition, at least as open source software is concerned, a powerful yet easy to use development environment for graphically modeling, testing and deploying business processes is still missing, thus smoothing the transition from BPM to workflow execution. Therefore, we suggest that a respective development effort should be started in the future.

REFERENCES

Adam, S. and Doerr, J. How to better align BPM and SOA – Ideas on improving the transition between process design and deployment. 9th Workshop on Business Process Modeling, 2008.


ABSTRACT
This paper presents an implementation of the design science research methodology (DSRM) in a study of scope issues in project management. The DSRM was selected in order to create a set of computational intelligence (CI) methods resulting in a design solution. This case study addresses the implementation of the six activities of DSRM that produced the design artifacts, with the details of the CI methods to be reported in a separate venue. The DSRM demonstration scenarios were appraised and critiqued by subject matter experts as one of the DSRM activities. That evaluation of the design artifacts verified that computational intelligence can be applied to a significant problem in project management.

KEYWORDS
Design science, project scope, computational intelligence.

1. INTRODUCTION
The motivation for this research is the high failure rate of IT projects due to scope. As recently as September 2011 the Harvard Business Review reported that although the average IT project cost overrun is 27%, one in six projects was an incredibly enormous failure (Flyvbjerg & Budzier, 2011) with cost overruns of 200% and schedule overruns of 70%. Their conclusions were that both the average of the project overruns was shocking, and that the outliers were extraordinarily extreme. Contributing new methods to help resolve IT project problems would meet a serious business need.

The design science research methodology (DSRM) was utilized in this study of project management scope. DSRM was an appropriate fit for this research which sought to create a design and architecture, leaving the implementation to a later phase. The artifacts produced were a set of methods as an application of computational intelligence (CI) defining a solution to a significant information technology problem. The research methodology allowed for the production of demonstration scenarios, which in this case study illustrated CI methods to ascertain the scope status for project activities. This paper addresses the application of the methodology with the results of the evaluation and the findings to be reported in a separate venue.

The design outputs of this study showed that computational intelligence can mitigate problems in monitoring scope on information technology (IT) projects. Heretofore computational intelligence had only been applied to project planning (Wang & Hao, 2007) and project estimation (Azzeh, et al., 2010) or obscure topics such as the selection of a project manager (Wi, et al., 2012). This study considered an important constraint of projects in a manner that differs from previous research efforts in two major regards.

The first is the shift from applying computational intelligence in the early planning and estimating stages to the monitoring and controlling processes during the execution phase of an IT project. Secondly, this study investigated monitoring a subjective constraint, scope, instead of objective constraints such as time and cost. Drucker stated that controls should be "appropriate to the character and nature of the phenomena measured" (Drucker, 1993, p. 500). By implication a scope monitoring and control system should match the subjective, ill-defined nature of scope events. The scope constraint had not been addressed in the past because it was assumed that measuring subjective criteria was impossible. CI methods and advances in computing systems have made this assumption dated and false.

The next section gives the background of the problem that was addressed, and a brief outline of the benefits and selection of computational intelligence. The remainder of this paper goes into detail on how this
study implemented each of the six activities in a design science research methodology, thus contributing an
innovative design to a significant issue in project management.

2. PROJECT MANAGEMENT AND COMPUTATIONAL INTELLIGENCE

That a significant percentage of IT projects end as failures is well documented (Levinson M., 2009). For
high cost projects Cook reported that approximately 3 percent of projects a with labor cost over $10 million
are successful (Cook, 2007). If IT failures occur between 5% to 15% of the time, Business Insider
extrapolated that to wasting $50 to $150 billion dollars per year in the United States alone (Hardy-Vallee,
2012). The cost of IT project failures is extremely high, and an issue of great importance.

Many times vague requirements and poor scope management were significant contributing factors
(Levinson M., 2008). Examples are abundant: the bankruptcy of FoxMeyer Drug in 1996 due to an IT project
that had scope problems (Bulkeley, 1996) or the $170 million project failure by McDonalds Restaurants due
to scope issues (Youngkuk, 2008). Another example is in 2008 Levi Strauss & Co. reported a drop in profits
from a faulty IT implementation (Perry, 2008) due to a $192 million charge against earnings for an IT project
that was estimated originally to cost less than $5 million (Flyvbjerg & Budzier, 2011). The management of
scope is a relevant and significant business problem.

2.1 The Nature of Scope Problems in IT

Monitoring and understanding scope status is fundamental to the management of information technology (IT)
projects (Schwalbe, 2010), but status reporting and analysis has been a major problem in IT projects (Snow
& Keil, 2002). Many times IT projects fail due to mismanagement of scope constraints (Kerzner, 2011)
(Gido & Clements, 2009). Schedules and budgets have visible measurements in calendar days and funds
spent, but scope is often subjective. Not having an objective unit of measurement for scope on IT projects,
makes managing scope is especially difficult because status reporting is word based (Schwalbe, 2010).

Project managers have lacked techniques for handling qualitative data as might be found in scope status.
Brooks pointed out that software programming is both invisible and tractable, therefore assessing scope
status can be error prone (Brooks, 1995). In a study of complex projects it was found that soft issues such as
are found in scope are difficult to measure, but can provide early warnings of problems (Klakegg, et al.,
2010). Those same researchers stated there needed to be measures beyond cost and schedule to act as leading
indicators of project success. Rather than incremental improvements to existing techniques that monitor
costs and schedules, this study created a novel alternative by monitoring scope.

2.2 Computational Intelligence as a Potential Solution

Zadeh's concepts of fuzzy sets provided the fundamental principles for the computational intelligence
methods used in this study (Zadeh, 1965). Works by others (Zimmermann, 1996) (Klir, et al., 1997) (Cox,
1999) offered practical guidance for implementing the theories first espoused by Zadeh. In his first paper on
fuzzy sets Zadeh described the benefit of fuzzy sets as providing "a natural way of dealing with problems in
which the source of imprecision is the absence of sharply defined criteria of class membership rather than the

McNeill and Thro defined the characteristics of fuzzy sets as word based, nonlinear, changeable, and
analog (McNeill & Thro, 1994), which are also the characteristics of scope on an IT project. Fuzzy logic
works well for those situations where there is vagueness and uncertainty that normally would be resolved
using human reasoning (Chen, Wu, & Cudre-Mauroux, 2012). Because CI systems are a computing paradigm
to handle imprecise data, they offer methods and algorithms to capture and process fuzzy inputs. Scope status
on software development projects has those same properties of imprecision and vagueness and therefore CI
was selected for the design of a solution.
3. DESIGN SCIENCE APPLIED TO PROJECT MANAGEMENT

3.1 The Design Science Research Methodology

For IT research Hevner and March distinguished design science from natural science by stating that "design science addresses research through the building and evaluation of artifacts" (Hevner & March, 2003, p. 112). The term "artifacts" to describe products of design science originated with Simon, who stated that an advantage of creating artifacts or interfaces was the ability "to characterize the main properties of the system and its behavior without elaborating the detail of either the outer or inner environments" (Simon, 1996, p. 9).

Wieringa clarified what might be meant by an artifact for software engineering by enumerating algorithms, techniques, methods, tools, notations, or conceptual frameworks (Wieringa, 2010). This research built artifacts that were computational intelligence methods to handle subjective, non-quantitative project constraints. The descriptive evaluation of design science was utilized to confirm that demonstration scenarios built around the artifact proved its utility to subject matter experts.

Expanding on Hevner and March's framework, Peffers, Tuunanen, Rothenberger, and Chatterjee proposed a set of principles and procedures for design science research that they believed integrated the best practices in common use (Peffers, et al., 2008). When they reviewed case studies in the computing field they identified six activities that they found was shared by most researchers in DS research. They argued that their analysis represented the current state of published literature on design science for information systems, emphasizing that design science solves problems by applying theories, not by building and testing hypotheses. Their analysis resulted in a formal process for research, including a model for the evaluation of DS research in information technologies.

Their definition of the basic elements of an IT design science methodology established principles of how to write hypotheses and the evidence required to support the conclusions. This study implemented Peffers, Tuunanen, Rothenberger, and Chatterjee's definition of a design science research methodology (DSRM) as six research activities. The six activities fit into the "build and evaluate" framework for design science established by March and Smith (Hevner & March, 2003). The six activities are: (1) identify an important problem, (2) define objectives for a solution, (3) build artifacts, (4) demonstrate the artifacts, (5) evaluate the artifacts, and (6) communicate the importance and novelty of the artifacts (Peffers, et al., 2008).

This study built and evaluated computational intelligence (CI) methods for monitoring IT scope. This was an innovative application of CI to a significant issue in IT project management. The research product chosen to be built was the design of methods implementing leading edge computational intelligence concepts. Design science was determined to be the appropriate approach for a research methodology, and is juxtaposed to theorizing in natural science as described in March and Smith's framework for IT research (March & Smith, 1995).

3.2 Implementing the Six Activities of DSRM

3.2.1 Identification of a Problem in IT Project Management

Having selected DSRM as a methodology, this study started with the first step in the design science research methodology, which was to identify a problem of importance to information technology professionals. A literature review found that managing scope on projects has historically been a significant problem in the IT field. This has not changed over time as shown recently by a survey of professional project managers in May 2012, which reported that the number one reason projects fail is scope creep (PMI, 2012).

One key to success in managing IT projects is the monitoring and controlling process during the performing and executing of a project. Projects are constrained by factors such as time, cost, and scope (Gido & Clements, 2009). If the project is drifting from the constraint objectives, then it is important for management to recognize the variances and to make adjustments. The Project Management Institute (PMI) identified processes and methods that can be used to manage cost, time, and scope on projects (PMI, 2008). For example they offered the critical path method as a recommended technique that can assist in time
management. For cost management they suggested using the earned value method to calculate cost variances. For the scope constraint, change control processes can help to manage that constraint.

Fleming and Koppelman, proponents of the earned value model, stated that a prerequisite to accurate measurement of project cost performance was a complete scope definition (Fleming & Koppelman, 2010). They pointed out that software projects are notorious for undefined scope or poor requirements, adding that implementing earned value on an IT project might not be appropriate when scope is incomplete. Furthermore earned value measures cost expenditures after events have transpired, which means earned value is a lagging indicator. Additionally, earned value explicitly monitors costs, and only by implication might highlight scope problems after the funds have been expended. Traditional tools such as earned value have limited capacity for assessing the status of scope on IT projects.

Often scope has the properties of being vague, subjective, and imprecise. Snowden and Boone stated that most organizations are faced with complex to chaotic problems that require sensing skills in managers (Snowden & Boone, 2007). As Klakegg’s team pointed out it is those fuzzy gut feelings that contain potential insights into project problems (Klakegg, et al., 2010). This finding was supported by Kerzner who would add that the business world is full of nontraditional projects with changing technologies, ill defined statements of work, and assumptions that must be altered during long duration projects due to new business needs (Kerzner, 2011).

With so many different sources of scope problems, and the potential severe impact of negative scope events, a project manager must quickly identify scope issues so that corrective actions can be taken. The first step in the design science research methodology was to identify a problem of importance to information technology professionals that needed to be addressed, and scope met that criteria. The next step was to search for solutions that would prove of value to project managers.

3.2.2 The Objectives for a Solution to Scope Problems in IT Project Management

The second step in the design science research methodology was to define the objectives for the design. The objectives that formed the basis of the demonstration and evaluation activities later in this study were threefold. The first was to determine whether scope status can be captured for a task in progress by using computational intelligence methods when that status was vague, imprecise, or unclear. The second was to determine whether linguistic hedges provided an ability to enhance the interpretation of the scope status for tasks on a project critical path. The third objective was to explore how computational intelligence methods might be used to capture leading indicators for the scope constraint.

Hevner, et al., stated that business organizations exist in an economic environment, and that a design must fit within that constraint (Hevner, et al., 2004). They believed that the objective should be to "produce feasible, good designs that can be implemented in the business environment" (Hevner, et al., 2004, p. 88). Implicit to this objective was that the costs of implementing a given design were reasonable, an objective that was incorporated into the evaluation activity.

The objectives could be generalized as the search for emerging methods or approaches to address problems that were previously considered unsolvable by technology. The goals can be decomposed into the applying CI methods to produce project management artifacts that were innovative, implemented leading edge concepts, and addressed an important and relevant problem.

3.2.3 Creation of Artifacts

The third activity in this study's implementation of the design science methodology was the building of artifacts which were selected from March and Smith's research outputs: constructs, models, methods, or instantiations. This study focused exclusively on creating methods, in particular computational intelligence methods. Methods can be defined by solution processes using formal, mathematical algorithms (Hevner & March, 2003) which was the means chosen in this study.

There were three sets of design artifacts created to illustrate capturing vague, fuzzy qualitative data. The first artifacts implemented computational intelligence in the design of the input mechanisms, the second the design of the backend processing, and lastly the design of interpretation and presentation in reports.

The inspiration for a structure that was used in the design of the research artifacts was Zimmermann's description of mechanistic Mamdani fuzzy controllers (Zimmermann, 1996). Instead of controlling physical devices, the artifacts of this research monitored and controlled IT projects. For Mamdani controllers the input was electrical signals, whereas for IT projects the input would be the scope status. A customized web gadget
replaced the signals, and became the input mechanism to collect the subjective impressions or judgments as to the status of scope. The web interface was modeled after that proposed by Barranquero and Guadarrama (Barranquero & Guadarrama, 2010).

The design defined the software algorithms that might be utilized in an implementation. Computing algorithms such as those prototyped by Barranquero and Guadarrama would generate an mathematical overlay onto the fuzzy user inputs. Calculations using methods provided by Zimmermann (Zimmermann, 1996) would accomplish the backend processing. The resulting design artifacts showed how to gather fuzzy opinions, or perceptions, from users to monitor project scope status.

The design of the non-numeric scale for the artifacts was such that it was easy to understand and use by experienced project managers. The design assumed that project managers should not need knowledge of how computational intelligence works. DSRM methods can be defined by solution processes using formal, mathematical algorithms (Hevner & March, 2003). The CI methods and fuzzy algorithms utilized in the creation of artifacts will be reported in a separate venue.

3.2.4 Demonstration of the Artifacts

Whereas the third activity defined the selected computational intelligence methods and algorithms, the fourth activity in DSRM was to demonstrate that those processes were capable of meeting the design objectives. To demonstrate the capturing of subjective opinions as to project status, a collection of artifacts were built containing both illustrative diagrams and computing inputs and outputs to the CI processes.

The artifacts demonstrated CI processes by illustrating in diagrams and detailed in sample outputs from the CI methods. This research study created multiple demonstration artifacts that equated to a variety of stoplight style dashboard reports in a format that would be familiar to project managers. Stoplight colors were used with "green" being an acceptable status, "yellow" being marginal, and "red" representing a project in trouble.

One demonstration illustrated a status where all activities were on target. A written description of the current status to be evaluated was accompanied by the screen capture of the data input using the CI web gadget so that a project manager would interpret the status as "green". Demonstrations were also created to illustrate the marginal or "yellow" status, which might range through varying shades: yellow leaning toward green, pure yellow, and yellow leaning to red. Another demonstration was designed such that the input should be construed as status "red". Although the real possibilities are infinitely variable, these alternatives illustrated a small but representative subset of the universe of potential inputs.

Included in the demonstration was an exploration of how leading indicators and computational linguistic hedges for the critical path might be handled by CI methods. Conventional techniques expend resources then monitor, so that awareness of problems with scope would appear after time and money had been wasted. The demonstrations presented how scope status can be captured as a subjective opinion before an activity has started, thus providing an alert to problems with the scope constraint much sooner in the project life cycle. This would give the project manager the opportunity to apply corrective actions, and thus acts a leading indicator.

These design artifacts were presented to multiple researchers and practitioners as demonstrations of the CI concepts. This is described in more detail in section 3.2.6 under the communications activity. The evaluation of the artifacts by subject matter experts occurred after the communications of the designs took place, and after the improvements were incorporated into the design. The evaluation is described in the next section.

3.2.5 Evaluating the Artifacts

Peffers, et al., in their integrated best practices in design research listed the fifth activity in the design science research methodology (DSRM) as the evaluation of artifacts (Peffers, et al., 2009). In order to perform the fifth activity of DSRM, Hevner, et al., enumerated five alternative techniques to consider using when evaluating information technology design science: observation, analytics, simulations, tests, and description (Hevner, et al., 2004). The descriptive evaluation technique could use arguments to convince or could use scenarios built around the artifacts to prove the utility. This study created six detailed scenarios for IT projects by expanded upon and adding to the demonstration artifacts. Each scenario contained 46 project activities with each activity identified as a line item in the standard project management reports.

These scenarios were then evaluated by subject matter experts (SME) to validate the relevance of the artifacts. The experts who participated in the evaluation were project managers in the information technology
field, each of whom: 1) had practical field experience managing IT projects, and 2) possessed the Project Management Professional (PMP) certification. This fulfilled March and Smith's criteria that a subject group should exercise the artifacts (March & Smith, 1995).

These design artifacts were presented to multiple diverse research audiences as demonstrations of the CI concepts. This is described in more detail as part of the communications activity. The evaluation of the artifacts by subject matter experts occurred after the communications of the designs took place, and after the improvements were incorporated into the design.

The expert evaluators were given an evaluation package of the multiple project scenarios that were related to each other as time snapshots of a project in progress. In the first section of each scenario the SME were asked to review and confirm the quality of information provided in conventional project management reports. This control set included an earned value report, a critical path Gantt chart, and a brief executive summary.

After responding to that first section the SME were asked to critique a second set of new, additional information from the computational intelligence methods for monitoring project scope. They were shown the results of CI methods having processed the fuzzy inputs to determine the scope status for a given activity. The research gathered the SME opinions and observations as to the impact of the additional information provided by monitoring scope using CI methods. There were both structured questions and open ended questions to collect the SME feedback.

When reviewing the first set of conventional reports the subject matter experts were in general agreement and confirmed that the status reported in the conventional reports was in close proximity to what they would have reported themselves. For the scenarios where the CI methods contained no new information, the expert evaluators found that the CI methods produced results consistent with the conventional reports. The determination of the experts was that the CI methods properly reported when there was no change in status, and that the CI methods did not overcompensate, or erroneously change the meaning of the status.

For the evaluation scenarios where the CI methods added new data for scope the subject matter experts found that the CI methods produced good results. The new data was a subjective opinion of the status, collected by using CI methods, and contained additional information not found in the conventional budget and schedule reports. The evaluators found that getting this additional, albeit subjective, information gave them new insights into the condition and progress of a project. The significant finding from the evaluation was that all SME agreed that the additional data from the scope monitor had a major impact with respect to their conclusions about the status of an activity. For example, when conventional reporting methods indicated an okay "green" status but the new data from the scope monitor indicated a "yellow" status, this new scope information changed their perception of the activity. That new understanding became a catalyst to initiate corrective actions.

For the evaluation scenarios which presented the subject matter experts with CI methods using linguistic hedges, their analysis of the design was modestly positive. Some found that the CI methods produced acceptable results, but one evaluator was ambivalent about the effectiveness of the methods. Some of the evaluators found that getting information that highlighted the critical path gave them insights into the condition and progress of a project. Others wanted more personal control over the declaration of the status, which was counter to Snow and Keil's reservations about doing so (Snow & Keil, 2002). The evaluators wanted precisely what Snow and Keil's research found did not work well: project managers with total control to self-report status.

The results from the evaluations of the scenarios for using CI methods as a leading indicator or early warning of scope issues was very favorable. Scenarios were built to determine whether computational intelligence methods applied to a project's scope could produce leading indicators or early warnings of project problems. All of the SME found that the CI methods produced valuable information for future activities or activities that had just started. In the scenario where it was clear that there was scope creep in the form of additional work that had to be performed, the evaluators found that the early warnings should mobilize project managers to obtain additional funding, schedule relief, and/or rebaseline the project.

The DSRM process that produced these findings conformed to March and Smith's criteria for the evaluation of design science artifacts, which stated that methods should be operationally capable of doing the design task (March & Smith, 1995). One SME said that the visualization of the scope status increased the information for a project manager, while another SME responded that the visuals helped manage projects. A third SME stated that "scope status provides insights that might otherwise go unreported" which would be converted into corrective actions.
The first objective for the evaluation activity was to determine whether scope status can be captured for a task in progress by using computational intelligence methods when that status was vague, imprecise, or unclear. This objective was confirmed by the expert evaluators. The second objective was to determine whether linguistic hedges enhanced the interpretation of the scope status for the project critical path. The opinions of the SME were mixed, but generally positive. The third objective was to see if CI methods could capture leading indicators for the scope constraint, and objective that was positively confirmed by the SME.

3.2.6 Communications

The sixth activity in DSRM was to communicate the importance and novelty of the artifact to both IT researchers and professionals. In order to address the two differing communities papers were presented at conferences representing the two disparate sets of interests: researchers working in computational intelligence and project management professionals.

The demonstration of the artifacts was communicated at four different peer reviewed conferences ranging from computer scientists interested in the computational aspects to project management researchers and project professionals. This was done to meet the objective that DSRM communications should disseminate "the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness" (Peffers, et al., 2008, p. 56). Feedback from the conferences was then incorporated in the building of an improved design. The artifacts evaluated by subject matter experts included the design improvements made after the communications of the designs took place.

4. CONCLUSION

Through the execution of the design science research methodology this study demonstrated that computational intelligence can be applied to the monitoring of the scope constraint. Hitherto computational intelligence had only been applied to the early project phases of planning and estimating. Computational intelligence offered the most potential for solving issues in monitoring scope during the execution phase of information technology (IT) projects.

The design science research methodology was an excellent fit for this research which sought to produce a set of methods and have those methods evaluated and critiqued by experts in the field. Those CI methods proved to be an innovative and creative application of information technology. This paper presents the results of the DSRM as a case study in implementing the DSRM for the project management domain. The design artifacts that were demonstrated in the study showed that computational intelligence methods could mitigate monitoring issues on IT projects. Those CI inspired artifacts were at the core of the evaluation package appraised by subject matter experts.

The current research was limited to the design of the methods and the critique of the effectiveness of those methods by IT project management professionals. Based on the positive evaluation of the CI methods by subject matter experts this research is prepared to move to an instantiation of the design artifacts. This would create opportunities for empirical investigation of the CI methods in production projects. This research was limited the demonstration and evaluation of methods for IT projects, but the methods and findings described could be generalized to any type of projects, offering new methods for managing projects.

REFERENCES


THE OWL-S EXTENSION FOR THE PERVERSIVE SYSTEM

Fatma Achour, Anis Jedidi and Faiez Gargouri

Multimedia, Information Systems and Advanced Computing Laboratory

ABSTRACT

The goal of the semantic web, also known as a third generation, is to improve the web service research, discovery, selection, composition and integration. The pervasive systems correspond to a complete communication framework which allows the communicating objects to recognize and locate automatically. The pervasive system tasks are permitted by the semantic web services. The main interest of our research is to propose an adaptation framework of the application to the pervasive system based on semantic web services.

In this paper, we present a part of our research work which represents the description of an OWL-S ontology extension to describe the pervasive system. This extension symbolizes the first level of data description in our pervasive system adaptation.

KEYWORDS

Web service; semantic; OWL-S; pervasive system; adaptation; description;

1. INTRODUCTION

The creation of a conceptual adaptation system for the pervasive application is the interest of several researchers. We face that the proposed framework helps programmers to implement their adaptation systems by providing an adequate concept to a particular situation. This proposal is based on two creation-levels of web services that are interconnected via adapters. Each web service has a virtual sensor to update data. It is described by OWL-S ontology to switch from a standard web service to a semantic web service and to integrate contextual information in each web service. In the present paper we study the description first level of the web service by a generic OWL-S extension proposal to describe the global variable of a pervasive information system.

In the next section, we review the existed OWL-S standard to describe the semantic web services. In Section 3, we interest to the pervasive information system description. In Section 4, we propose a classification for the pervasive information system concepts based on the existed model to describe this system. Finally we present the proposed OWL-S structure extension.

2. THE STANDARD OWL-S TO DESCRIBE THE SEMANTIC WEB SERVICE

OWL-S is a language based on the DARPA work of its DAML program and takes the result of DAML-S (DARPA Agent Markup Language Service). It was incorporated in W3C in 2004 within the interest group on semantic web services at the OWL recommendation (M.David et al., 2004). The original purpose of OWL-S is to implement semantic web services. OWL-S is based on OWL to define the abstract categories of entities and events in terms of classes and properties. OWL-S uses this ontology description language to define a particular ontology for web services. This ontology is used to describe the web service properties as well as its services available to the public. The ontology main classes described by OWL-S are as follows (OWL-S, 2012)

- The ontology "Service": represents the main class of OWL-S. It covers the web service general properties. This class has a "ServiceProfile", described by a "ServiceModel" and supports a "ServiceGrounding".
- The ontology "ServiceProfile": explains the functionality of the service and what it requires to other agents, it describes the service in terms of what it does to allow a requester to see if the proposed service suits him.
- The ontology "ServiceModel": defines the functioning of the web service and serves to explain how the service works. A web service can be seen as a process. For this reason, the "ServiceModel" has a subclass "ProcessModel".
- The ontology "ServiceGrounding": provides the information necessary for the use of the web service. In fact, you should choose the appropriate protocol to access the service, the message format, the way to serialize, the used transport mechanisms and the way the addressing mode is utilized.
- The ontology "Resources": provides information about the resources used by the web service. Web services often need resources to run. These resources are many and various. It is, therefore, interesting to regroup them in the ontology.

The relation between OWL-S main classes is represented by the schema in figure 1.

Figure 1. The existing OWL-S extensions

In the literature concerning the web service adaptation, there are several works that take the existing OWL-S structure advantage to describe different contexts. In this paper, we discuss two research works of Qiu et al., (Q.Lirong et al., 2006), (Q.Lirong et al., 2007) and Ben Mokhtar (Ben Mokhtar et al., 2005).

Qiu et al., research works propose an adaptation system based on the service composition approach. To do this, the authors offer three context categories (Q.Lirong et al., 2006).
- The user context ("U-Context"): this category specifies the context information about the user. In this context, the authors defined two types of contextual information: the user static context (profile, interest, and preferences) and the user dynamic context (location, current activity and task trying to achieve).
- The web service context ("W-Context"): this category includes the not-functional contextual information (price, execution time, confidence degree)
- The environmental context ("E-Context"): this category collects the context information about the user's environment (time, date, etc.).

Each context category is represented by an OWL ontology and integrated with the existing OWL-S extension ontology to introduce the OWL-SC (OWL-S for context) (Q.Lirong et al., 2007). The latter is intended to describe a general contextual information (see Figure 2) based on the user description.

Figure 2. The OWL-SC Ontology (Q.Lirong et al., 2007)

The proposed structure is focused only on the user context description. However, it presents a vision for the integration or the addition of more information to the OWL-S structure.

Ben Mokhtar et al., research works propose a system to adapt the web services to a pervasive environment (Ben Mokhtar et al., 2005). The context definition includes the description of four types of contextual information: the context sensors, services, devices and users. In addition, the contextual adaptation in this work is based on;
• The service representation: the authors describe the services using OWL-S extended with context information. This information is decomposed into a high level context attributes, preconditions and contextual effects.

• The user task representation: the user task representation is performed while extending the OWL-S service model ontology. To do this, the authors propose to integrate the quality conditions service descriptions and the context conditions required by the user task in the OWL-S structure.

The context information description is performed by means of an OWL extension ontology, the adaptation is carried out by applying a finite-state automation.

Figure 3. The OWL-S ontology extension for the pervasive system (Ben Mokhtar et al., 2005)

Ben Mokhtar et al., their proposal concerns the contextual information integrated in OWL-S structure, but this information does not relate to the pervasive system description. We focus on, via this work, the integration of pervasive contextual information in an OWL-S structure.

3. THE PERVASIVE INFORMATION SYSTEMS (SIP)

The most accurate and the most used definition of the pervasive system resolved by Agoston research works (Agoston et al., 2000); "pervasive system makes information available anywhere and anytime". These systems must be used in different contexts depending on the user's environment and the user's profile as well as the used terminal. Among the pervasive system characteristics:

• The use of lightweight, controllable and wireless devices,
• The network architectures with an automatic configuration,
• The high distributed environment with a heterogenic, mobile and an autonomous structure.

In contrast to the traditional information systems, these new systems integrate different mobile devices with different hardware and software capabilities and other useful features for this system type (T.Chaari, 2007). In fact, with these systems, the mobile phone, for example, is no longer used for simple communication. PDAs are no longer just a planning and organization gadgets.

The pocket PCs are no longer isolated from the Internet. These devices must interact according to their uses contexts in order to meet user's need. Accordingly, a traveler can check and send his documents according to the characteristics of the wireless networks available in an airport, a patient can make an appointment with his doctor from his PDA. A manager can view the status of his work at home.

In addition, the pervasive information system designers must provide an architecture and a mechanism to store, retrieve and efficiently send the most relevant information to the user irrespective of location, time and the equipment that he uses.

4. THE SIP DESCRIPTION

4.1 The Model used for the SIP Description

In the literature for the SIP description, there are several models that may be mentioned as SOUPA, Activity, CSCP, etc. In this paper, we use the model that we proposed in a previous work (Achour et al, 2012). This
model is represented by an UML class diagram which includes a set of interconnected classes. This model is represented by the figure below (see Figure 4).

![UML class diagram](image)

**Figure 4. The general model used to describe the pervasive information system**

The represented model includes a set of interconnected classes. We distinguish the existence of four types of classes; "Preferences", "Rules", "Role" and "Time" (Achour et al., 2012).

- **Agent**: this class is used for the presentation of different actors in a pervasive system. It assembles the human actor and the device actor.
- **Persons**: presents all human actors.
- **Device**: presents the peripheral devices in pervasive system.
- **Service**: presents the services offered by each device.
- **Networks**: regroup the characteristics of the different types of networks.
- **Location coordinates**: represent the spatial relation between the different locations in a pervasive system.
- **Preferences**: present the information profile of the person who realizes the activity in a pervasive system.
- **Activity**: presents the characteristics of the activity requested by the user.
- **Rules**: regroup the different rules of activity, person and network interacting in a pervasive system.
- **Time**: presents the characteristics of temporal things and the relation of different things in a pervasive system.
- **Locations**: represents the characteristics of localizations of human and mobile devices in a pervasive system.

### 4.2 Contextual Information Classification in a SIP

The presented UML model is transformed into an OWL ontology. Through this transformation, we distinguish the existence of six sub-ontology. Each ontology represents a context category. The following figure illustrates the different contextual information categories contained in a structure description of a pervasive information system.

The UML class diagram presented in Figure 4 displays the six types of contextual information:

- **User Context (Who?)**: contains information describing the human user situation, either directly or indirectly. The classes that represent this context type: person", "preferences", "role" and "rules".
- **Physical Context (Where?)**: represents the physical environment in a pervasive information system. The classes that represent this type of context: "location" and "location coordinates".
- **Network context (where?)**: combines the characteristics of all available networks in pervasive information systems. The classes that represent this type of context: "network" and "rules."
- **Activity context (What happens, when?)**: combines information that represents the activity and the execution time of this activity in a pervasive information system. The classes that represent this type of context: "activity", "time" and "rules".
• **Device context (What can be used?):** represents the profile and device activity in a pervasive information system. The classes that represent this type of context are: "activity", "time" and "rules."

• **Service context (What can be achieved?):** regroups information about the functions that the pervasive system can provide. The classes that represent this type of context, "services" and "rules."

![Diagram](image)

**Figure 5. Different context categories contained in a SIP environment**

5. **THE PROPOSED OWL-S EXTENSION**

5.1 **The OWL-S Generic Extensions**

The semantic web service allows associating the semantic concepts with the web service in order to lead to a better search, discovery, selection, composition and interrogation.

Thus, OWL-S provides constructions to specify information about the composition and the access service means. The main OWL-S component, service profile provides a web service general description that can be published and shared to facilitate the service discovery. Our proposal focuses on the OWL-S extension ontology to support the pervasive system characteristics.

To fully describe the pervasive context, we propose to add six sub-ontologies to the "pervasivecontext" ontology. The latter includes all the features of a pervasive system. Each ontology represents a well-defined context in a pervasive system.

- **U-Context:** This ontology is used to describe the user context. It includes the static and the dynamic user's characteristics and preferences.
- **A-Context:** This ontology represents the characteristics of the existing application to a device as well as the rules for using this application.
- **D-Context:** this ontology represents the device characteristics.
- **S-Context:** This ontology represents the services offered by a device in a particular pervasive system context.
- **N-Context:** represents all available networks in a specific context with characteristics, connection rules and preferences.
- **P-Context:** represents the user's physical context in a pervasive system. The physical context designs the user's location.

![Diagram](image)

**Figure 6. The proposed OWL-S structure for the pervasive system**
5.2 Detailed Description of the Proposed Ontology

The relationship between the OWL classes is presented by the schema in the following figure (see Figure 6). In fact, the pervasive context is presented by the "PervasiveContext" OWL class. The activities in a pervasive system are presented by the "A-Context" OWL class. They exist in a device. The latter is symbolized by the "D-Context" OWL class. Each device "D-Context" offers services in a pervasive system.

The services are presented by the "S-Context" OWL class. The latter regroups the characteristics of the services provided by the pervasive system. All the devices existing in a pervasive system are interconnected via multiple networks. These networks are modeled through the "N-Context" OWL class. The two classes "D-Context" and "U-Context" represent the entire agent existing in a pervasive system. It is for this reason that we placed the two classes as sub-class of "Agent" OWL class.

Each of the presented classes in the proposed OWL-S structure will be transformed in ontology. The latters regroup classes and attributes presented by the OWL semantic relation "owl:onProperty". The purposed ontology are used to detail the contexts defined in the pervasive system.

![Figure 7. The relationship between classes of proposed OWL-S structure](image)

5.3 The Proposed Semantic Web Service Architecture

In this section, we integrate the proposed OWL-S structure in the semantic web service structure. Thus, the classical web service architecture (see Figure 8) is composed medium with three elements. The first element represents the user. The second element represents the provider and the last element represents the registry.

The user is presented by a user-program. The provider permits the description of a service medium of WSDL language. The registry is a database regrouping the WSDL description. UDDI is responsible for registering the services and applications to find the services that meet their needs in a standardized method. The interaction between the three elements is assured by the SOAP protocol.

![Figure 8. Architecture of classical web service](image)
In the following, we describe the integration process of the proposed OWL-S structure in the classical web service structure. This description is integrated in double sides. In the user side, we integrate this structure to present the user's requirement. In the provider side, we present the pervasive context description obtained by the interaction with the sensors.

![Architecture of a semantic web service](image)

Therefore, there exists an interaction between the web service elements and the proposed structure to describe the pervasive system. This description ensures the semantic and the dynamic of the proposed web service.

### 5.4 An Example of using the Proposed OWL-S Structure

In the future works, we present an OWL-S structure for each context described in this paper. In this section, we present a scenario to give an idea about the classes and the attributes contained in each ontology described in Figure 7.

![The rule representation](image)

The presented scenario (see Figure 11) is resulted by applying the representation of the rules exemplified in figure below. In other words, rules are defined by a set of conditions. The latters are resulted by of a request user values by means of logic operators ("AND" or "OR"). The value used in this presentation is manipulate by means of the two operation "getValue()" and "setService()". The rule result may be one service or several services related by a logic operator.

**The scenario definition:** A user in an airport waiting for a flight. It has a large multimedia file. He wants to send it to the wireless network in a sending time does not exceed 30 minutes.

**The scenario result:** In this scenario, three context types are defined; the physical context, the activity context and the network context. Among the classes of the physical context "PhysicalContext", we have the class "location" that has the attribute "LocationName". In the existing structure, we note the existence of three possible values: airport, work and home. In this situation, the sensor detects that the user is at the airport. This value is returned by the method "getUserLocation()".

Across the context of activity "ActivityContext", we can extract the type and the execution time of the activity. The type activity is returned by the attribute "ActivityType" of the class "Activity" in this situation which includes three possible values: play online, chat on facebook and send multimedia documents. The potential value in this case is expressed by the method "getActivityType()". The activity execution time is...
returned by the attribute "ExecutionTime" of the class Time" which includes in this situation the values: 15 minutes, 30 minutes and 45 minutes. The potential value in this case is expressed by the method "getExecutionTime()". The final context is the network context "NetworkContext". It allows returning the network to be used in this scenario. The class "Network" has an attribute "Bandwidth" which includes the bandwidths value of all networks stored in this structure. This value is perceptible by means of virtual sensors.

Figure 11. The design result of presented scenario

6. CONCLUSION AND FUTURE WORK

In this paper, we presented an initial pervasive system description by the proposal of an OWL-S extension. This extension is integrated in a semantic web service to describe a pervasive system in a generic way. The purpose of this web service is to create a conceptual adaptation of applications for pervasive environments.

In the future work, in order to pass the first level of description to a second more detailed level, each ontology described in the proposed web service will be detailed and will be incorporated into web services. OWL-S extensions that will describe each proposed context of web service description.

REFERENCES


ROLE OF WEB PERSONALIZATION IN CONSUMER TECHNOLOGY ACCEPTANCE

K. Vinodh and Saji K Mathew
Department of Management Studies - Indian Institute of Technology, Madras - Chennai, India

ABSTRACT
Consumer acceptance of technology is vital for understanding the motivating factors involved in technology acceptance and adoption. Whereas most academic attention has gone to understanding user acceptance of technology in organizations, some recent studies have extended this research to consumer context. With the evolution of Internet commerce and its wide adoption resulted in academic research focus on recommendation systems and web personalization. This study seeks to understand how web personalization influences consumer technology acceptance in an E-Government setting. A recent theory of consumer acceptance was extended to study the impact of Web Personalization as a moderator. Our results show that personalizing the web by self-reference and content relevance has a significant moderator role in influencing the relationship between determinants of intention to use on user acceptance in certain cases.

KEYWORDS
Consumer Technology Acceptance, Web Personalization, E-Government.

1. INTRODUCTION
With the growing Internet economy and improved processing power (Faloutsos, Faloutsos and Faloutsos, 1999), web personalization has found increasing applications in E-Commerce and other web related information portals (Schafer, Konstan, and Riedi, 1999). e.g. Google news has been personalized based on user behavior (Das et al., 2007). Web personalization is defined as any action that makes web experience of a user personalized to the user’s taste (Mobasher, Cooley and Srivastava, 2000). In web personalization the content and navigation are personalized to each user based on their browsing behavior and other demographic data related to the user (Mobasher, Cooley and Srivastava, 2000). Applications of web personalization concentrated on customizing products or services for maximizing user satisfaction and have been found to deliver better results over non-personalization (Tam and Ho, 2006). The literature in the area of Web Mining and Web Personalization (Kosala and Blockeel, 2000) are studied extensively in the context of E-Commerce (Adomavicius and Tuzhilin, 2011). Several successful firms engaged in E-Commerce harness technology for improving their business. Consequently, consumer acceptance of electronic platforms for buying and selling of products and services has been an area of focused research attention.

Technology acceptance studies have provided understanding about the adoption pattern of new technology by users (Taylor and Todd, 1995). This research started when organizations tried to understand the impact of technology in workplace environment (Davis, 1989). Theory of reasoned action (TRA) was one of the early models explaining the factors affecting the behavior of a person (Fishbein and Ajzen, 1975). Attitude and subjective norm were proposed as determinants affecting the intention of a person. Intention of a person was expected to affect the behavior of a person in long term. This model was succeeded by Theory of Planned Behavior (TPB) (Ajzen, 1991). TPB introduced perceived behavior control as another antecedent to the existing model proposed by TRA. Technology Acceptance Model (TAM) is one of the highly cited models and widely accepted theory (Davis, 1989). TAM introduced perceived usefulness and perceived ease of use as the main determinants affecting the intention to use a system. TAM is accepted by many researchers and used in most of the technology acceptance theories. Venkatesh et al. (2003) tried to integrate eight such highly cited theories and proposed the Unified Theory of Acceptance and Use of Technology (UTAUT). He proposed four antecedents and three moderators affecting the behavioral intention to use the system and in
turn the actual usage of the system itself. Most of these studies were done in organizational perspective. Venkatesh, Thong and Xu (2012) later extended UTAUT to Consumer Acceptance and use of Information Technology (UTAUT2) to study the determinants affecting the consumer technology acceptance. This is one of the recent studies on consumer technology acceptance. Consumer acceptance of technology is vital as most companies are targeting consumer usage of technology as their potential business source. The advent of Internet and the numerous devices have transformed consumer technology acceptance studies vital and need of the hour. Interestingly there are very few research studies done in this area.

This study focuses on the phenomenon of user acceptance of information technology in E-Government domain (Silcock, 2001) and seeks to understand how personalizing the web could impact the intention to use technology for availing a Government service. This research extends a recent theory in technology acceptance 'Consumer Acceptance and use of Information Technology' also known as UTAUT2 (Venkatesh, Thong and Xu, 2012) by including web personalization as a new dimension. Previous studies that integrate social cognition and consumer research decision behavior in information systems literature are studied.

2. WEB PERSONALIZATION IN CONSUMER TECHNOLOGY ACCEPTANCE

UTAUT2 is a recent theory in the consumer technology acceptance context. The study was conducted in the context of mobile Internet usage. Venkatesh, Thong and Xu (2012) proposed seven antecedents affecting consumers’ intention to use a technology; Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price and Habit. Age, Experience and Voluntariness were proposed as moderators in the above model. Performance expectancy is the degree to which an individual believes that using the system will help him or her to attain gains in job performance. From a consumer oriented perspective, it is related to task oriented performance improvement wherein an individual expects that his individual performance would improve by using the technology. Effort expectancy is the degree of ease associated with the use of the system. Users tend to consider the effort required in using the system with adoption of a technology. Social influence is related to the effect of peer thoughts and activities on the behavior of a person. It is the degree to which an individual perceives that important others believe he or she should use the system. Facilitating conditions is belief of an individual that the necessary resources to use the system will be available. The presence of facilitating conditions will impact the user’s behavioral intention to use the system. Hedonic motivation represents the fun and pleasure derived from using the system. It is characterized by novelty and innovativeness of a technology. The consumer’s intention to use a system is influenced by the monetary cost associated in using the system. In a consumer setting, the user has to bear the expenses as against an organizational setting. Consumers think about the difference between perceived benefits from the system and the total costs involved in using the system. Habit has been conceptualized as the degree to which people tend to behave automatically because of learning. A related concept here is experience and reflects the passage of time from the initial use of technology. The detailed effect of each construct is measured in UTAUT2. It was found that all the seven constructs significantly impacted the behavioral intention to use a technology.

Web Personalization is an important web technological concept which has the potential to influence user behavior. It has known to impact the web usage experience of consumers. As against mass customization, web personalization involves individual preferences rather than a group’s interests. Web personalization covers both the content presented and presentation formats used. Web Personalization has been studied in different research streams and in various contexts. Web Personalization literature from various streams has been introduced here to bring out the relative importance of web personalization. Due to its importance and growth, the effect of web personalization in technology acceptance is studied in this research. Various concepts from Computer Science, HCI, Marketing and IS have served to develop the integrated discipline of Web Personalization as a separate research area.

Web personalization research from information systems perspective tries to capture the cognition behavior of users (Tam and Ho, 2006) and understand how user decisions are influenced by web stimulus. There are many studies trying to bring out the dissipation of information over Internet. The cognition behavior of people changes when the format of web content provided to users changes (Jiang, 2007). The perception of the user in understanding the details provided over Internet is directly affected by web
personalization. People tend to give more attention to online animations (Hong, Thong and Tam, 2004). Also self-reference made by websites tends to capture the attention of users and makes them more responsive. Presentation formats have been found to impact user behavior where video formats are used (Jiang, 2007).

Although web personalization and technology acceptance have been studied independently in various streams, the role of web personalization in user acceptance of technology has not received due attention. This study addresses this gap by empirically investigating web personalization as an influencing factor in consumer acceptance of web based services.

3. WEB PERSONALIZATION FOR E-GOVERNMENT

The use and impact of information and communication technologies in business and Government organizations have significantly changed over the last few decades (Willcocks, Feeny and Olson, 2006). E-Government systems are intended to provide fast and easy access to Government information, enable open Government, people’s right to know, transparency and responsiveness (Yildiz, 2007). Improving managerial effectiveness through Government process automation used to be the major role of technology in Government organizations until the widespread diffusion of personal computers and the introduction of the Internet. Technology adoption for E-Government has grown significantly with the Internet, particularly in developed countries and ICT has been considered as a strategic resource (Yildiz, 2007). Impacts associated with the use of technology in Government has been viewed from two perspectives, technological determinism where the features of a given technology drives its usage and social determinism where choices made within social structures determine the impact of a technology (Heeks and Bailur, 2007). Some studies have suggested that impacts associated with E-Government are largely the result of choices made by the human agency in a social context and the features of technology plays a lesser role (Heeks and Bailur, 2007). Technology has found to bring change to traditional bureaucracy (Jain, 2004). Our study focuses on the phenomenon of user acceptance of information technology in E-Governance domain and seeks to understand how personalizing the web could impact intention to use technology for availing a Government service.

4. PROPOSED MODEL

We extend the UTAUT2 model by including Web Personalization determinant. Web Personalization is modeled as moderator in the new model. The six constructs from UTAUT2 namely performance expectancy, effort expectancy, facilitating conditions, hedonic motivation, price and habit are expected to have a positive influence on intention to use a technology in the presence of Web Personalization. Social influence is not hypothesized to influence the intention to use the system because, E-Government services in the context of social influence is not relevant. Social Influence is more related to the peer influence and does not impact in voluntary setting of using E-Government portal.

Performance expectancy in the context of online usage of a Government service is about how a user expects a technology to help complete a given task. Previous research has shown that web personalization, content relevance in particular moderates cognitive processing in online environment and thus influence buying decision (Tam and Ho, 2006). Therefore we hypotheses that: H1: Performance expectancy will have a stronger impact on intention to use an online channel under a higher level of Web Personalization, all else being equal. H2: Effort expectancy will have a stronger impact on intention to use an online channel under a higher level of Web Personalization, all else being equal.
In the case of online E-Government services, consumers have different levels of access to information and other resources that facilitate the use of online channels. Therefore all things being equal lower facilitating conditions will lead to lower intention to use and higher intention to use an online channel. H3: Facilitating conditions will have a stronger impact on intention to use an online channel under a higher level of Web Personalization, all else being equal.

Innovativeness, novelty seeking and perceptions of novelty of a technology could influence the behavioral intention to use a technology (Venkatesh, Thong and Xu, 2012). As web personalization includes personal stimuli recognized as novelty by the seeker (Tam and Ho, 2006), we expect that: H4: Hedonic motivation will have a stronger impact on intention to use an online channel under a higher level of Web Personalization, all else being equal.

Similar to an E-Commerce setting where price could be a determinant of intention to use a technology, cost of availing a service could be a key determinant of intention to use an online service in e-governance context. The perception of cost could be reduced by the reduction in transaction costs experienced by the users while using an online channel. In the presence of personalized content we expect that perception of cost will be still lower and overall price value will be more (Venkatesh, Thong and Xu, 2012). H5: Price value will have a stronger impact on intention to use an online channel under a higher level of Web Personalization, all else being equal.

Passage of chronological time could lead to differing degrees of habit based on extent of interaction and familiarity formed with the target technology (Kobsa, 2001). H6: Habit will have a stronger impact on intention to use an online channel under a higher level of Web Personalization, all else being equal.

5. RESEARCH METHODOLOGY

The items used in the model were derived from previously tested and validated theories. The items pertaining to Web Personalization were derived from Information systems Research by Tam and Ho (2006) and items related to the antecedents were derived from UTAUT2 modified to suit the E-Government context. Tam and Ho (2006) deals with Web Personalization affecting the cognitive processing of users. These items were used to measure the self-reference and content relevance of the web pages presented to the user. The items were adopted as it is with minor changes in the questionnaire relevant to passport site. Likert scale was used from range of 1 to 5. The scale corresponds to strongly disagree, disagree, neutral, agree and strongly agree. Experimental method was followed in a laboratory set up for data collection in the study.

We followed an experimental method in a laboratory set up for data collection in our study. Our research design was intended to collect responses from two groups, one who received personalized content while using a web technology and the other group who did not receive any personalized content. This one factor
two level experiment was followed by administration of a questionnaire to understand the impact of Web Personalization in E-Government Acceptance. Indian Government Ministry of External Affairs website for passport (http://passportindia.gov.in/) was chosen as our E-Government service site for experimental purpose. We chose this online E-Government service as the most appropriate application for our study because online passport service is one of the important E-Government services targeting majority of citizens. The impact assessment of major E Government projects were recently conducted by Indian Institute of Management Ahmedabad (IIM-A) under the directive of the Department of IT, Government of India. The passport site was found to have less impact when compared to other channels. Hence choosing passport site for understanding the consumer acceptance of technology was more relevant. In order to overcome the cost to the citizens in the manual process of passport related filings, ‘Passport Seva’ was introduced as a web application with a user interface that provided various options for different passport related needs of citizens. But the current passport site was not personalized. There was redundancy in data capture and also certain degree of ambiguity as some questions posed were unclear and not self-explanatory. Further the site asked for some information such as Police Station code which the user might be unaware at the time of filing. Hence the web interface must provide support for such data which needed further search prior to filing passport during the course of online application filling. When the data provided to customers are personalized and remembered by the system, we expect that customers would accept the system and tend to revisit the site.

Our experimental set up was done in the IT Lab of a premier national Institute with students as target audience. A pilot study was conducted before the start of the actual experiment with research students working in the lab to ensure content validity of the instrument used in the study. The students participating in the subsequent experiment were offered vouchers from an online book store as incentive. Passport site was mirrored and was run in a local server. We developed two sets of each passport application page, one with normal passport site forms and other with passport site personalized based on user specific data. The respondents were organized randomly into two groups, Group A and Group B based on roll numbers. Odd roll numbers were formed as Group-A and even roll numbers as Group-B. The passport pages were loaded in a local server and were made available for experiment in the machines present in the lab. The laboratory housed personal computers of the same make and similar configuration (Hewlett Packard PCs with Intel Dual Core Processors). Group-A received a set of pages without personalization and formed the control group. Group-B members were provided web personalization and thus formed the treatment group.

6. ANALYSES

Partial Least Squares (PLS) path modeling was used in R statistical package version 2.15 for Structured Equation Modeling (SEM). Measurement model estimation involved confirmatory factor analysis (CFA) and reports results of construct uni-dimensionality, validity and reliability. The pilot was run with 15 students and the main experiment was run with a total of 150 students. PLS path modeling was used as the sample size was relatively small with resampling and bootstrapping methods (Tenenhaus et al., 2005). Measurement model was valid in our research indicating internal consistency, reliability and discriminant validity. The results were derived from Cronbach’s α, DG ρ and Average Variance Explained. All item loading were > 0.6; all the values of Cronbach’s α and Dillon-Goldstein’s ρ were above 0.7.

The results of structural model are presented in Table 1. Structural model brings out the relations among the constructs in the model and provides a basis for testing the hypotheses proposed in this study. The inner model results reported by plspm package showed R square value of 0.604 indicating that the model has 60% explanatory power. Two approaches were used to test the proposed hypotheses: (a) a full structural model with endogenous, exogenous and interaction variables; and (b) individual path models with and without interaction terms to test moderation effect. Since all the variables had reflective measures with interval scales, product term approach was followed by measuring moderating effects as product terms of the independent variables and the moderator variables (Henseler and Fassott, 2010). Following the method suggested by (Joreskog and Wang, 1996), the mean of the indicators of the latent independent variables were multiplied with the mean of the indicators of the latent moderator variable.
Table 1. Structural Model results of PLS path modeling.

<table>
<thead>
<tr>
<th>Behavioral Intention</th>
<th>Direct Effect</th>
<th>Interaction Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>R square</td>
<td>0.71</td>
<td>0.59</td>
</tr>
<tr>
<td>PFE</td>
<td>0.078</td>
<td>0.149*</td>
</tr>
<tr>
<td>EFE</td>
<td>0.036</td>
<td>0.14*</td>
</tr>
<tr>
<td>SOI</td>
<td>0.130*</td>
<td>0.14*</td>
</tr>
<tr>
<td>FAC</td>
<td>0.042</td>
<td>0.14*</td>
</tr>
<tr>
<td>HED</td>
<td>-0.045</td>
<td>0.06*</td>
</tr>
<tr>
<td>PRI</td>
<td>0.476*</td>
<td>0.26*</td>
</tr>
<tr>
<td>HAB</td>
<td>0.272*</td>
<td>0.18*</td>
</tr>
<tr>
<td>PFE*WBP</td>
<td>-</td>
<td>-0.01</td>
</tr>
<tr>
<td>EFE*WBP</td>
<td>-</td>
<td>-0.02*</td>
</tr>
<tr>
<td>FAC*WBP</td>
<td>-</td>
<td>-0.02</td>
</tr>
<tr>
<td>HED*WBP</td>
<td>-</td>
<td>-0.04*</td>
</tr>
<tr>
<td>PRI*WBP</td>
<td>-</td>
<td>0.02*</td>
</tr>
<tr>
<td>HAB*WBP</td>
<td>-</td>
<td>-0.007</td>
</tr>
</tbody>
</table>

Social influence, price and habit were significant (p<0.05) in the direct effects while other relationships were not significant. All six constructs were directly and significantly affecting the Behavioral intention in the presence of web personalization. Three hypotheses were supported against six proposed.

6.1 Hypotheses Not Supported

Web Personalization doesn’t have a significant moderation effect on the relationship of Performance Expectancy on Behavioral Intention. Performance Expectancy is defined as the degree to which using a technology will provide benefits to consumers in performing certain activities. Unlike the findings reported by Venkatesh, Thong and Xu (2012), Performance Expectancy also did not have a direct and significant effect on Behavioral intention. In the context of this study, E Governance Passport site cannot be related to any job related or task related performance improvement directly. In consumer context it is related to improvement in task oriented efficiency. Users could not attribute the performance improvement from E Governance passport site. Hence there is no moderation effect of Web Personalization on Performance Expectancy on Behavioral Intention. Web Personalization did not significantly moderate the effect of Facilitating Conditions on Behavioral Intention. Facilitating Conditions refer to consumer’s perceptions of the resources and support available to perform a task. We didn’t provide any helping resources or support for working in the E Governance Passport site. The moderation effect of Web Personalization on Facilitating Conditions was not significant. Web Personalization didn’t have any significant effect on the impact of Habit on Behavioral Intention. Habit is defined as having prior experience in using the technology and the extent to which an individual believes the behavior is automatic. The usage of passport site was new to many users and there was no prior experience in using the system. Also the users were made to use the system only once during the time of experiment and there was no pre and post testing of the usage behavior. Hence there habitual behavior of using the system was not significantly affected by the moderation effect of Web Personalization.

6.2 Interesting Results

Unlike hypothesized, Web Personalization negatively affected the relationship of Effort Expectancy on Behavioral Intention. When revisited the theory, women tend to plan the effort required for any task before starting any work (Venkatesh et al., 2003). In the sample studied, 82% participants were male as against 18% female. The sample was skewed towards men and hence consisted of majority of respondents who did not
form expectations about effort required to carry out the task. Since the female members were very few, the moderation effect was possibly negative.

Hedonic motivation effect on Behavioral Intention was negatively moderated by Web Personalization. Hedonic motivation is defined as the fun and pleasure in using a technology. Innovativeness and novelty in using the technology is important determinant in using the technology. When consumers begin to use a technology, they give more importance to novelty an later it reduces. In E Governance Passport site is very static and task-oriented and there is no novelty in the system as such. Further previous studies have shown that younger men tend to give more importance to novelty in technology (Chau and Hui, 1998). As explained earlier, the participants of the experiment were young people and mostly male group. This possibly explains the negative moderating effect of web personalization on Habit to Behavioral Intention relationship.

7. CONCLUSION

Several studies have addressed web personalization and its purposeful implementation in marketing and E-Commerce setting. There is also a vast body of literature that intently focused on developing theories on user acceptance of technology in organizational and consumer settings. However Acceptance of web technologies continues to be a huge challenge in domains like E-Government where citizens are provided access to Government services through online channels. This study addresses this research gap by extending a recent theory in technology acceptance to understand the role of web personalization in E-Government context. This study makes three important contributions to the body of knowledge in information systems. First, studies on web personalization from information systems perspective has been scarce as most studies in this area have algorithmic focus. Second, this research extends the UTAUT2 model proposed for understanding user behavior in technology acceptance by including web personalization as a moderator. Third, studies on Web Personalization have been predominantly focused on E-Commerce domain as recommender systems generated potential financial benefits for firms engaged in using Internet channels for business transactions.

This research is one of the early attempts to test the impact of web personalization on user acceptance of a technology. This study is also distinct in applying web personalization in the context of E-Government. Consumer technology acceptance theory is studied in the context of E-Government portal. Notwithstanding the important contributions to the body of knowledge related to Web Personalization, there are also some limitations to this study which might restrict the application and generalization of the findings. This study used a sample of under graduate and graduate students from a premier engineering Institution. As the sample represents an educated population, this study may fail to generalize to citizens with different demographic characteristics. Also the sample chosen had most representation from male students and is skewed towards a category. Further, the sample size was relatively low, and attempt was made to overcome this limitation by using sub sampling by bootstrapping method.

The findings from this study have important implications for management practice. With the growing adoption of the Internet and improved quality of service through electronic channels, higher levels of user acceptance in E-Government would serve to improve quality of governance. As commercial web applications have successfully implemented personalized services, web based E-Government services could also benefit from embedding Web Personalization strategies in web design, data capture, analysis and offering self-reference and content reference relevant to a user’s behavior. This strategy could potentially improve the use and decision to re-use E-Government portals by citizens, as in the case of students seeking passport services. Further studies could empirically test the change of user acceptance behavior with gender, age, income, education and other demographic attributes. Future studies could also focus on impact of web personalization in E-Government services with different characteristics such as direct cash transfers, income tax filing and local Government services.
REFERENCES


INTEREST AREA ANALYSIS OF PERSON AND GROUP USING LIBRARY’S CIRCULATION RECORDS

Toshiro Minami
Kyushu Institute of Information Sciences & Kyushu University Library - 6-3-1 Saifu, Dazaifu, Fukuoka 818-0117 Japan
& Hakozaki, Higashi, Fukuoka, Japan

ABSTRACT

The first aim of this paper is to make a modeling framework of the interest area of a library patron by utilizing library’s circulation records. In other words, to profile a person with his/her interest field. Interest area profiling is not only interesting of itself but also useful for library when it chooses purchasing books, for professors when they give lectures, and for other people. The eventual goal of the study presented in this paper is to develop various data analysis methods that provide with useful tips in assisting people, including library patrons, as they learn. The second aim is to develop some useful analysis tools for such pedagogical purpose, especially for analyzing the library data and lecture data. In this paper we propose a concept of virtual faculty of a member of university, which is defined based on the interest area profile of a patron and a faculty. We also give a comparative study between patron and faculty. Even though the approach and analysis methods presented in this paper are in the primitive stage of the research toward this direction, they have a high potential and are expected to be developed to be matured and be practical in the future.

KEYWORDS
Knowledge Management, Knowledge Discovery, Library Marketing, Data Analysis, Data Mining, Library Data

1. INTRODUCTION

Thanks to the development and popularization of ICT (Information and Communications Technology) our society is getting to be knowledge-oriented and it will be going on toward the future. Libraries have been playing an important role in society as a public service that provides us with a strong support when we study and acquire knowledge. They are supposed to keep playing even more important social role in knowledge and skill acquisition in the knowledge-oriented society. Especially, university libraries are supposed to strengthen their learning supporting services even more, because they are part of educational organizations.

In order to obtain effective plans for strengthening learning assisting functions, it is a hopeful approach to develop data analysis methods from various data sources such as library data, lecture data, and other ones. By using such objective data, the tips and know-hows obtained in the data analysis are supposed to be also objective. In this paper, we use circulation records from Kyushu University Library in Japan. We have pursued a couple of case studies and have shown the usefulness of library’s circulation records. We define the concept of interest area as a profile of a library patron and show what kinds of characteristic features of a patron we can see from the profile [8]. We also define the profile of a group of patrons in a similar way. We apply this concept to the faculties of Kyushu University and see some characteristic features of faculties.

We define two user-profiling measures so that we can compare user-profiles easier than just see and check the profiles themselves. We compare a group of patrons and the faculties using these measuring indexes. We then define the similarity measure of two profiles using cosine similarity. With this measure we can investigate the similarities between patrons, between faculties, and patron and faculty. We can define the concept of virtual affiliation, or faculty, of a patron as the faculty that has the highest similarity in its interest area profile in comparison with other faculties. We can see that many patrons have the same virtual faculty as the real one the patron belongs to, but some patrons have different virtual faculties instead of the real ones.

The rest of this paper is organized as follows: In Section 2, we describe the target data for analysis. In Section 3, we define the concept of interest area profile of a patron, and interest range size and earnestness. We then investigate how to capture the patron’s behavior and extend the definitions to a group of patrons,
and apply them to the comparative study of faculties, and we discuss the relations between patrons and faculties. Finally in Section 4, we summarize what we have done in this paper and prospect our future works.

2. TARGET DATA FOR INTEREST AREA PROFILING

We use the circulation records obtained from the Central Library of Kyushu University, for the academic year 2007; i.e. from April 2007 to March 2008, which were used also in our papers [4-6, 8]. The data contain 67,304 circulation records. A record consists of the book ID, book's NDC classification number (Nippon Decimal Classification), call number, borrower's patron ID (renumbered in considering privacy), borrower's affiliation, borrower's type, and the timestamps for borrowing and returning dates and times, etc. The number of patrons who borrowed at least one book is 6,118 and the average number of books per patron is about 11. The borrower types include 10 kinds: undergraduate (Bachelors-1 to 6, or B1 to B6), masters' (M), Ph.D (D), academic staff (Professors, P), and others (O). Figure 1 shows the ratios of patron types and affiliations. The faculty names stand for, AG for Agriculture, DD for Dental, DS for Design, EC for Economy, ED for Education, LA for Law, LT for Letter, MD for Medicine, NC for the special faculty called 21st century program, which is for the students who wish to study a wide variety of fields, O for whom that do not belong to other faculties, PS for Pharmaceutical, SC for Sciences, and TE for Engineering. It is easy to see that students are the majority borrowers and B3 and M students occupy the big shares among students. Also we can see that SC (Sciences) overcomes other faculties, followed by AG (Agriculture) and LT (Letter).

As a preprocessing, we eliminate the records that have inappropriate values and even have no data for the inevitable properties (items) that are necessary to deal with in the analysis presented in this paper. For example 244 records have NDC numbers that are greater than 1,000 and 7,260 records have the non-numeric values for this item and thus have eliminated from the original records. There are 53,182 records that are left after eliminating such records. The number of patrons in these remaining records is 5,718. As the result, about half (53%) of books are borrowed by undergraduate students and 23% by masters' and 13% by Ph.D students. Thus about 89% of books are found to be borrowed by students; which supports based-on the objective data that the frequently-told saying that most important patrons of university libraries are students.

3. INTEREST AREA PROFILE AND ITS APPLICATION TO COMPARATIVE STUDY BETWEEN PATRONS AND FACULTIES

This section deals with interest area profile [8]. First in Section 3.1 we define using the circulation records and show the profiles of some representing patrons and of faculties. In Section 3.2, we define interest range and strength of an interest area profile. Finally in Section 3.3, we define a new concept of similarity of profiles and investigate those between the patrons and the faculties.
3.1 Interest Area of a Patron and a Group of Patrons for Profiling

The intending aim of defining the concept of interest area is to understand the patrons in terms of their eagerness, style, preliminary knowledge, etc., for learning. Our interest in this paper is on analyzing the areas of interest of a patron, or what subjects or topics the patron is interested in. We are hoping to obtain information about the patron’s expertise field together with the related field he/she wishes to learn.

The concept of the profile of a patron in this paper is defined by using the library’s circulation records [8]. For the areas of topics, we use the NDC number which is assigned to the books as a part of their bibliographical information. NDC is a decimal classification system like the world famous DDC (Dewey Decimal Classification) localized to Japan. The top level categories of NDC consist of the following 10 topic fields; 000 for General Works, 100 for Philosophy and Religion, 200 for History and Geography, 300 for Social Sciences, 400 for Natural Sciences, 500 for Technology (Engineering), 600 for Industry and Commerce, 700 for Arts, 800 for Language, and 900 for Literature. Note that NDC is different from DDC.

We define the profile of a patron as a vector with dimension 10, with each element corresponds to one of the 10 top categories of NDC. An element of the vector is the frequency of the borrowed books of the patron which have the corresponding top category numbers of NDC. Thus, for example, if a patron borrows 11 books with NDC number from 100 to 199.99, 12 books from 200 to 299.99, and so on until 19 books from 900 to 999.99, the profile vector of the patron becomes <11, 12, 13, 14, 15, 16, 17, 18, 19>. We can extend this definition to a group of patrons by just modifying the condition from “borrowed by the patron” to “borrowed by one of the patrons of the group.” It is possible to define other concepts in a similar way such as the profiles of properties of patron that relate more on knowledge level, learning ability, learning style, etc.

Figure 2 shows the interest area profiles of the top 11 patrons according to the number of items, or books in the left graph, and the interest area profiles of the faculties in the right graph. We chose them because firstly they are representative patrons among all the patrons and knowing them is important for library marketing, and secondly because quite a lot of patrons borrow only a couple of books and thus they are not appropriate to use as sample data for developing new methods for profiling the patrons. The top-most patrons from A to K (also called by P.A to P.K) borrows 388, 268, 185, 183, 173, 168, 167, 150, 148, 143, 143 books during one year, respectively.

It is easy to see in the figure that the ratios of books according to the classification number, or topic area, vary from patron to patron. For example, P.A borrows quite a wide area of books with NDC numbers from 000 to 900. On the other hand, P.C borrows mostly with the classification number 400 (Natural Science).

Such difference of the width of topic areas indicates a character of the patron in his or her interest range, or curiosity range. Together with the number of the borrowed books, this range can be good measures for characterizing features of a patron, which will be discussed in more detail in the next section.

From the right part of Figure 2, we can see that the faculties PS (Pharmaceutical) and SC (Sciences) have a very high top interest area at the NDC number 400 (Natural Sciences) and they are similar in this respect. On the other hand the faculties DS (Design), LT (Letter), and O (Other) have relatively low value in the top interest area and they have a wide range of interest areas. These results are somewhat matching to our intuitive images on these faculties. In this respect, it is interesting to see that DD (Dental) and MD (Medicine) have relatively wide interest areas, which is against our intuition.
3.2 Interest Strength and Interest Range

We define two measures of an interest area profile. They are intending to represent some characteristic features of the profile in two different points of view. The first one is the strength or magnitude of the interest of the patron and another is the width of the areas that the patron is interested in. Using such measures it is easier to compare the profiles. According to our previous work in [8], we survey the results on these concepts.

The interest strength is defined by the number of books, or items, that are borrowed by the patron or the group of the patrons. We define the interest area range, or range size, by the information entropy of the profile by using the ratios of the 10 NDC categories. Let \( p_i \) = number of the books that belong to the NDC category \( i \) divided by the total number of the books, or the strength, of the patron’s profile. Then the information entropy of the profile is calculated as the sum of \(-p_i \log p_i\). We use 10 for the base of the logarithmic function in order to make the maximum value to 1 because the number of NDC categories is 10.

Figure 3 shows the correlation between the range size and the strength of all patrons (left) and of the faculties (right). The range value 0 means that the patron borrows only one book. The range value is 1 if the patron borrows the books with all the NDC numbers, i.e. from 000 to 900, exactly the same number.

The patrons from P.A to P.K are named according to the order of the strength, or the number of borrowed books, so they are located in the upper part of the left graph. As has been predicted the range of P.A (0.952) is quite high: the highest among all patrons, so that it is located to the right-most and top-most place, which means he or she borrows the books from all the NDC categories with borrowing almost the same number of books each. Furthermore P.A borrows nearly 400 books, which are over 100 books more than the second patron, i.e. P.B, who borrows more than 250 books. P.A belongs to the other group (O) so that this patron represents the high interest range of the O group.

On the other hand P.C has the minimum range value (0.04), whose affiliation is SC and the year 4 undergraduate student (B4). This case also, the patron P.C is representing the characteristic feature of the faculty SC of having low interest range size. Like P.C the patrons P.D, P.E, P.G, and P.H are located in the left most part of the left graph with having the values less than 0.2, which means they borrow books with one category more than 80% of times and other ones less than 20%. Thus they have very limited range of interest. The patrons P.B, P.F, P.J, and P.K are located in the range with the range value from 0.3 to 0.5, which means, in roughly speaking, they mainly borrow books with 2 or 3 categories.

Among the best 11 patrons who are marked from P.A to P.K, there are 4 students with affiliation of SC (Sciences) in all, and 2 of them are B4, undergraduate at year 4, (P.C and P.H) and 1 (P.E) is B3 and another one (P.K) is M (Masters). The 3 undergraduate students have very low range values from 0.04 to 0.16. They are very concentrated in learning as the representing patron, and student, P.C. It is interesting to see that the remaining master’s student (P.K) has relatively bigger range value 0.49. He or she borrows the books not only in the natural science field (with NDC 400), but also the books in general topics (with NDC 000), social sciences (with NDC 300) and others as well.

There are 3 Ph.D students with affiliation LA (Law); namely P.D, P.F, and P.G. The patrons P.D and P.G have similar range values 0.12 and 0.10, whereas P.F has bigger value 0.35 than the two. The former 2 students borrow the books with NDC 300 (Social Sciences) mostly, whereas the latter student borrows not only the books of social sciences but also the books with NDC 800 (Language) as many as of 300.

By observing the right figure in Figure 2, we can see that SC is far away from other faculties in both axes. It has the lowest value in region size and the highest in strength, which mean that patrons in SC borrow the...
books in natural sciences (NDC 400) mostly and the number of the borrowed books are quite high, which probably means that their places physically locate very close to the library and it is quite easy for them to visit the library and borrow many books.

The faculties of PS (Pharmaceutical), DD (Dental), and LA (Law) are located in the left part from the line with the range size 0.5, which means that their patrons also borrows books of their expertise area mainly than other faculties. The reason why the numbers of borrowed books of PS and DD might be that their faculties locate in a different campus from where the library is, and the patrons in PS and DD visit the library in order to get the books they could not find in the libraries of their own campus. LA is, on the other hand, located in the same campus as the library and also the number of the members is larger than that of PS and DD.

It is interesting to see that DS (Design) and MD (Medical) are located in the lower right part of the graph where their range size is relatively large. Even though MD locates in the same campus as PS and DD, its range size is far bigger than these two. In order to find the reason of this fact, we investigate more on the patrons’ behavior. Anyway in some reason the members of MD visit the library in a different campus in order not to find the books relating to their study in their expertise field but to find books in a wide variety of books.

DS locates in a campus of it own, i.e. different campus from that of library and even farther than the campus for MD, PS, and DD. The strength, i.e. the number of borrowed books, is small probably because of this reason. DS is a faculty that relates both to engineering and design, and thus it is easy to guess that their interest range as a whole is wide. However it is still surprising that its range size is larger than any other faculties including O (Other, or unclassified) and that LT (Letter) also has high range size. The members of LT borrow not just the books of literature (NDC 900), but also those in other areas as many as of literature.

### 3.3 Similarity Analysis of Interest Area Profiles

Even if we can find similarities between two profiles just by looking them, it is often difficult to say how much similar they are. For example if we have three profiles, say A, B, and C, and we can “feel” that these 3 are similar, it is often very difficult to judge which is more similar between A and B, and A and C. In order to make such comparisons easier we introduce a new similarity measure between two profiles.

Since a profile is a 10-dimensional vector, we can use the cosine similarity. We define the similarity of 2 profiles P and Q as follows. Let P=<p1, p2, ..., p10> and Q=<q1, q2, ..., q10>. Then we define: Sim(P,Q) = P.Q / (||P||.||Q||), where P.Q is the inner product of P and Q; sum of pi.qi for all i from 1 to 10, and ||P|| and ||Q|| are the length of the vectors P and Q, respectively, where the length of P is defined as the sqrt(sum of pi.pi for all i from 1 to 10). The similarity value ranges from 0 to 1 as the value is the cosine of the angle between 2 vectors in the 10-dimensional Euclidean Space with the non-negative component values and thus the angle between them is from 0 to 90 degrees.

Figure 4 shows the similarities of the 11 patrons from P.A to P.K with the faculties. We can see the similarity values make 2 clusters with high similarity and low similarity for the faculties AG (Agriculture) and TE (Engineering) clearly. The values for DD (Dental), EC (Economy), ED (Education), LA (Law), PS
(Pharmaceutical), and SC (Sciences) also have two clusters, where the values may be expressed differently with two clusters plus one exception. The faculties like MD (Medicine), NC (New Century, or 21st Century), and O (Other) have no clear clusters.

In order to have better views of the similarities we divide the 11 patrons into 3 groups. Figure 5 shows their similarities to the faculties in 3 radar charts. We can see in Figure 5 (left) that the 4 patrons in SC have very similar patterns and thus their interest areas are not only similar in their region sizes but also in the areas themselves, even though their types vary from B3, B4, to M, and their strengths of profiles are from 185 to 143. Among 3 patrons affiliated in LA in Figure 5 (middle), P.D and P.G are very similar so that their lines nearly overlap. Thus their ranges are similar; 0.12 for P.D and 0.10 for P.G. Their strengths are little bit different; 183 and 167. Their types are the same; D. The rest patron, i.e. P.F, is quite different from these two students. P.F is also a Ph.D student (type D) and has almost the same interest strength of 168. But the preference to the areas is quite different. The range size is 0.35, so P.F prefers to read wider areas of books than the other two. Still P.F has similarity to other 2 in the sense the similarity values are very low against the faculties from PS to DD from the Figure 5 (middle). Interestingly this tendency is a kind of opposite to that of patrons of SC in Figure 5 (left) that the patrons of SC have relatively high values for these faculties.

The rest 4 patrons in Figure 5 (right) have their own patterns. P.A’s interest areas have relatively high similarities to most faculties, so we can guess this patron has quite a wide area of interesting topics. It is also supported by the range size value 0.95. P.B belongs to LT (Letter) and thus has quite a high similarity to LT.

Based on the observations so far we introduce the concept of virtual faculty, or affiliation, of a patron. The i-th virtual affiliation is the i-th similar faculty of the patron. We will call the virtual faculty for the 1st virtual faculty. Then, for example, the P.A’s virtual faculty is O and his/her (real) faculty is also O, and P.B also has the same real and virtual faculty LT. Among the 11 patrons from P.A to P.K, only 2 have different faculties; P.F has LA as the real faculty and EC as the virtual faculty, and P.J has O as the real faculty and LT as the virtual faculty.

To have a closer look, we can see that P.A has the similarities against the faculties in the order of O (0.91) > DS (0.89) > NC (0.81) > LT (0.79) > … > PS (0.56) > SC (0.54) > LA (0.52). Thus P.A’s 1st virtual faculty is O, followed by DS for the 2nd, and NC for the 3rd. For P.B, the faculty order becomes LT (0.58) > O (0.34) > MD (0.23) > … > SC (0.03) > PS (0.01). Even though the virtual affiliation of P.B becomes LT, the similarity value is much lower than that of P.A. So we can say that P.A is a typical member of the virtual faculty O whereas P.B is not so much typical as a member of LT.

Figure 6 shows the number of patrons who are affiliated with the real faculties (left) and the virtual faculties (right) from first to the third ones. We can see that the faculty that has most patrons as its members is SC. The numbers are 1,168 for real and 1,818 for virtual. The second largest real faculty in the number of affiliated members is AG (848). However the corresponding number of members in the virtual AG drops largely to 312. This fact will inspire that quite a many patrons affiliated to AG do not have the profiles that have different patterns from the total pattern of AG. The faculties of EC, MD and O have the similar phenomenons of dropping a lot of the numbers in the virtual affiliations from the real.
It is interesting to see that some faculties have quite many members as the 2nd and 3rd virtual affiliations. For example, PS, EC, and MD have quite a lot of members as the 2nd virtual faculties. Similarly, DD, NC, and DS have several times as many new patrons as their 3rd virtual faculties. We have no explanation yet on this phenomenon, and thus we need further investigation on this topic.

Figure 7 shows the ratios of the numbers of the patrons according to the virtual faculties for each real faculty. From this figure we can see that most (81%) members of SC have SC as their virtual faculty. PS has the similar tendency that 78% of the members have SC as their virtual affiliation. DD is kind of similar to these because 64% of the members have SC as their virtual affiliation. On the other hand only 34% of the members of TE have TE as their virtual affiliation, which is smaller than the ratio for SC as virtual faculty, which is 40%. In this respect MD is the most extreme case. Only 1% of the members have MD as their virtual affiliation. Among them 33% belong to SC and 14% to LT in terms of their virtual affiliations.

4. CONCLUDING REMARKS

Our eventual goal is not only to analyze the data from library and lectures and discover knowledge that is useful in giving better educational environment to students, but also to develop the more sophisticated tools for data analysis in this respect. As a primitive step toward such a goal we have defined the interest area profile. We started with discussing the importance of such approach in improving education. Then we defined the profile of a patron from interest area, and we define the concepts of strength and the range of the profile, and thus of the patron. We extended these definitions to the profile of a group of patrons. Finally, in Section 3, we introduced a novel similarity measure and we have found some number of interesting results. We also introduced the concept of the virtual affiliation/faculty of a patron and demonstrate its usefulness in understanding the patron’s interest areas in comparison with those of the faculties as a case study. The
relationships between real and virtual faculties of students may be able to use to characterize a university and its students, which can be a new approach to measuring a university.

Because of the usefulness of circulation records, they are used in evaluating of library collections [3]. They are usually analyzed with various kinds of statistical methods and to efficiently recognize the representative image of the total data. The system WorldCat Collection Analysis system [9], for example, provides an easy-to-use analysis environment to librarians, based on such standard statistical methods. A research on circulation record analysis for evaluating the usage of e-books is reported in [3]. In addition to these research based on the statistical methods, investigation of the association rules in classification category of books using a data mining method is reported in [1]. In our previous works [4-6] we defined the concept of expertise levels of books and patrons and investigated the expertise levels of faculties. Our methodology to library data analysis is applicable also to lecture data, which are another source of data for analysis [7]. Goda et al. developed a method for analyzing lecture data in a similar approach to ours [2].

Our future plans include (1) to investigate more about the characteristic features of a patron and a group of patrons, (2) to develop different concepts for measuring, indexing, characterizing some behaviors of a patron and of a group of patrons, and (3) to extend our research area in order to cover wider area by introducing different types of data including lecture data, other types of educational data, etc.

Even though our research direction is quite new and we have little studies that have similar methodologies so that the research level in this field is still very primitive. Furthermore it is difficult to obtain the library data due to privacy issues and thus we have to put more effort to demonstrate the usefulness of our approach in library marketing. Even with such difficulties, we are convinced from our experiences so far that our approach has high potential and thus it will create practical results in near future.

This research was partly supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (C), 24500318, 2012.

REFERENCES

ACTIVITY ANALYSIS OF FACTORS INFLUENCING SECONDARY SCHOOL TEACHERS’ ADOPTION AND INTEGRATION OF ICTs INTO TEACHING

Topoyame Susan Maselele1 and Raymond M. Kekwaletswe2
1Department of Informatics, Tshwane University of Technology
2Information Systems Department, University of the Witwatersrand
South Africa

ABSTRACT
This paper examines factors that influence secondary school teachers to adopt and integrate information and communication technologies (ICTs) into classroom practices. There have been evident investments on ICT infrastructure and equipment by Botswana government and those around the world, as a way of improving education. Despite these efforts, prior studies revealed that ICT adoption and integration by secondary school teachers is still lagging behind. This paper discusses factors that influences teachers’ use of ICTs in teaching and learning processes under three categories namely; personal, institutional and technological factors. This paper uses Activity Theory as a lens to analyse the activities that involve the use of computers in teaching and learning processes at a typical Botswana secondary school. With Activity theory, learning is seen as mediated action in which individuals or subjects construct meaning while they interact with artefacts and social others in their environment. This paper draws on an analysis of semi-structured interviews and observations, using Gaborone Secondary School as a case study.

KEYWORDS
ICT integration; ICT adoption; Information and Communication Technologies (ICTs).

1. INTRODUCTION
The introduction of ICTs into education has been widely expected to transform teaching and learning across the curriculum. Tino (2002) defines ICTs as a “diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information.” According to Buabeng - Andoh (2012), the term ICT encompasses the range of hardware (desktop and portable computers, data projectors, calculators, data-logging, and digital-recording equipment), software applications and information systems (Intranet, Internet). In this paper, ICTs refers to devices such as computers (including hardware and software (Microsoft applications: Word, Excel, PowerPoint, Database)) radio, cellular phones, data projectors, television and the Internet, which are found in most of the Botswana secondary schools. Integration involves identifying specific topics or aspects of the curriculum that could be mediated by information technology (Chriisholm et al., 2004). This means identifying certain topics from the syllabi and incorporating ICTs in their day-to-day teaching and learning. ICT integration can also be seen as a process of using any ICT tool such as hardware, Internet or software to enhance learning.

Rogers (2003) defines adoption as the decision of an individual to make use of an innovation as the best course of action available. For the purpose of this paper, Rogers’ definition of adoption is used. The rest of the paper is outlined as follows: first a review of related literature is given, this is followed by the theory underpinning the study, the research method followed is then given. The discussion and interpretation of factors influencing ICTs integration in teaching is given before the paper is concluded.
2. REVIEW OF RELATED LITERATURE

This section reviews literature and concepts that informed the study and subsequently this paper. It discusses factors that influence teachers’ use of ICTs in teaching and learning processes under three categories namely; personal, institutional and technological factors.

2.1 Personal Characteristics

Teachers’ educational level, age, gender, experience with the computer for educational purposes, and attitude towards computers are seen as some of the factors which can influence technology adoption.

2.1.1 Teachers’ Attitudes

The attitudes of teachers towards technology greatly influence their adoption and integration of ICTs into their teaching and learning activities. It is believed that if teachers perceived technology programs as neither fulfilling their needs nor their students’ needs, it is likely that they will not integrate the technology into their teaching and learning (Buabeng-Andoh, 2012). Hence, teachers’ attitudes greatly influence successful ICT integration teaching and learning (Keengwe and Onchwari, 2008).

2.1.2 ICT Competence

Computer competence refers to being able to handle a wide range of varying computer applications for various purposes. Teachers’ computer competence is a major predictor of ICT integration in teaching (Bordbar, 2010). Evidence suggests that majority of teachers who reported negative or neutral attitude towards the integration of ICT into teaching and learning processes lacked knowledge and skills that would allow them to make “informed decision” (Al-Oteawi, 2002, as cited in Bordbar, 2010). This suggests that teachers with more computer experience have greater confidence in their ability to use them effectively.

2.1.3 Gender

Research study by Wozney et al. (2006) revealed that male teachers used more ICTs in their teaching and learning processes than their female counterparts. Jamieson-Proctor et al. (2006) conducted a study on teachers’ ICT integration in Queensland State schools. Results indicated that female teachers integrated technology into their teaching less than the male teachers. However, more research is needed in this area to find out whether gender variable a predictor of ICT integration into teaching and learning or not.

2.1.4 Teacher Workload

The workload of teachers can influence their acceptance and use of technology in classrooms. Findings of a study conducted by Samarawickrama & Stacey (2007) on a large multi-campus urban university in Australia revealed that increased teacher workload affected the participants’ use of technology in teaching. This means that in order for teachers to implement new initiatives such as ICT integration, it is necessary to lessen their teaching workload.

2.2 Institutional Characteristics

It is imperative to understand institutional characteristics that influence teachers’ adoption and integration of ICTs into teaching and learning processes. They are discussed in the next section.

2.2.1 Professional Development

Buabeng-Andoh (2012) argues that teachers’ professional development is a key factor to successful ICT integration into classroom teaching. Similarly, Keengwe Onchwari (2008) state that ICT related training can also influence teachers’ attitudes towards computers. It goes without saying that professional development of teachers, whether pre-service or in-service, should encompass ICT use for successful ICT adoption and integration into teaching and learning activities.
2.2.2 Accessibility

Access to ICT infrastructure and resources in schools is a necessary condition for ICT integration in education. Effective ICT integration into teaching and learning in schools depends mainly on the availability and accessibility of ICT resources such as hardware, software, Internet, and others. Lack of access to ICT resources hampers ICT integration efforts. A study conducted by Yildirim (2007) revealed that access to ICT resources is one of the effective ways to teachers’ pedagogical use of ICT in teaching. Schools should therefore ensure that teachers have ample access to ICTs in order for them to realise their ICT strategic plans.

2.2.3 Technical Support

Technical support can alleviate fears and encourage teachers to use ICTs knowing that there will be fewer disruptions in their lessons. Becta (2004: 16) contends that “if there is a lack of technical support available in a school, then it is likely that technical maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns”. The above findings show that lack of technical support can discourage teachers from ICT adoption and ICT integration in teaching and learning activities.

2.2.4 Leadership Support

School leadership support is vital in encouraging teachers to use ICTs in teaching and learning processes. Becta (2004) also argue that effective ICT integration depends on the significance of good leadership. It goes without saying that for effective ICT adoption and integration, there is need for a strong leadership to drive a well-designed technology plan in the school.

2.3 Technological Characteristics

Technological characteristics affect ICT adoption and integration. According to Rogers (2003) innovation attributes such as: relative advantage, compatibility, complexity, trialability and observability influence the rate of adoption. He further states that there is need to understand the perceptions of an innovation, as this has strong influence on future prediction of adoption of specific innovation. Teachers are more likely to adopt and integrate ICTs in their lessons if they deem them to be beneficial to teaching and learning, and if they have technical support whenever they need assistance.

   All in all, if teachers perceive an innovation has an advantage over the existing technology, compatible with their social needs, easy to adopt, it can be trialed before use and finally the results can be seen, it is likely that teachers will adopt and integrate it quickly (Buabeng-Andoh, 2012).

3. THEORETICAL FRAMEWORK: ACTIVITY THEORY

Activity theory (AT) has gained popularity in IS research and has been used in several studies similar to the present paper. Some of the authors who did research in AT and ICT integration studies are Demiraslan and Usluel (2008) and Lim and Chai (2008).

Activity Theory emphasises that activity is a collective phenomenon, involving several actors (Engeström, 1993). AT makes use of elements which could be used in data analysis. The framework allows an explicit way of interpreting the mediating influences of the tools used, the rules that apply, and the division of labour that exists among a community of people that engage in actions directed to an object and an outcome (Ditsa, 2003).

Activity Theory posits that people participate in an activity with the aim of achieving a goal. The goal is directed towards an object that is used to produce an outcome. The interaction between the individual and the object is made possible by tools. Subjects form part of the community and the relationship between the subjects and community is mediated by the rules and division of labour (Cassens & Kofud-Petersen, 2006).

The elements of AT in relation to the present paper are mapped as follows (adopted from Demiraslan and Usluel, 2008): Subject – Teacher (teaching experience, teaching approach, the personal, administrative and instructional use of ICTs, the necessity of knowledge and skills related to ICTs).

Object – the actors’ actions. In this paper, object refers to the goals of integrating ICTs into the teaching and learning process (knowledge and skills acquisition, and problem solving).
Tools - ICTs, methods which are used, problems which are encountered.

Rules - The evaluation criteria, expectations of the teacher and student, rules of the school, teachers, school administration, and ICT coordinator.

Division of labour - The roles and responsibilities of teachers, cooperation among teachers, the support of administration.

Outcome - The reflection of the use of ICTs in teaching and learning activities

Community – students, teachers, school administration and ICT coordinator

AT uses the term contradiction to indicate a misfit within elements, between them, between different activities, or between different developmental phases of a single activity (Sujan et al., 2002). The introduction of ICTs into the activity systems is likely to bring about contradictions. In this paper, any factor that inhibits ICT adoption and integration will be seen as contradictions of the activity system.

4. METHOD

4.1 Participants

This paper draws upon the findings of a case study conducted in Gaborone Senior Secondary School (GSS). The participants of the study were twenty teachers, of which ten were interviewed while the other ten were observed during authentic teaching lessons in classrooms or laboratories. Following on the qualitative research nature of the study, samples were small in size. When data was analysed there came a point of diminishing returns where increasing the sample size no longer contributed new evidence (Ritchie et al., 2003). The participants’ age ranged between 26 years and 52 years. Teaching experience of the participants ranged between 3 to 23 years.

4.2 Case Study Context

GSS is located in Gaborone, the capital city of Botswana. Each class has an average of forty students. There are no computers in classrooms, and one department has a working computer in the workroom. Teachers and students use the same computer lab. The school has an ICT coordinator who assists in resolving minor technical problems such as ordering and replacing cartridges, creating user accounts and informing the government Information Technology department to fix computers and printers when necessary.

4.3 Data Collection

As mentioned above, data collection was obtained through observations during authentic classroom teaching lessons and interviews with teachers under the following themes: ICT resources, connectivity and access in GSS; exposure to ICTs and ICT utilisation; impact of ICTs on learning; and barriers and challenges of ICT integration. The participants were interviewed for approximately 45 minutes each.

An observation form was developed to guide the observation process in order to find out ICTs usage in the day-to-day teaching and learning processes. The observation was aimed at finding out the following:

• Usage of ICTs in teaching and learning activities (if any)
• Teacher/learner attitudes in lessons where ICTs are used compared to those where they are not used
• Teacher proficiency in ICT integration
• Learner engagement/participation during lessons of ICTs usage

5. DATA ANALYSIS

Content and thematic analyses were used to analyse data from the interviews, as well as observations. Tape recorded interviews were transcribed and then analysed in terms of the identified themes and categories drawn from AT, namely: Subject; tools; object; rules, community and division of labour. Data from
observation was analysed according to the prescribed categories, marking the frequency of each category. Observation findings were used to support the content analyses results. Factors which influence teachers’ adoption and integration of ICT are discussed in the next section.

6. FACTORS INFLUENCING TEACHERS’ ADOPTION AND INTEGRATION OF ICTs IN TEACHING - FINDINGS AND DISCUSSION

Due to page limit and constraint, this section briefly discusses findings and interpretation of factors that influence the adoption, following themes and elements of the activity theory.

6.1 Tools

The findings indicate that there is a serious shortage of ICTs in GSS. The school has one computer lab which has twenty six (26) networked computers, one printer, one scanner and three data projectors. These resources are primarily meant for use by Computer Studies students. The school has thirteen (13) departments and only one has a working computer in the workroom, no printer, one binding machine and a very slow Internet connection. The Art and Design department has ten (10) old working computers which they use for projects and Graphic Design examinations. These computers do not have Internet connection and the department has only one A3 colour printer which they use mainly for printing projects of all Art and Design students. The Graphics Design teacher expressed his frustrations in teaching the module as his department’s only data projector was not working at the time of the interview. He said this takes up much teaching time to explain a concept without the use of the data projector. Many teachers stated language as one of the barriers of ICT integration.

Inadequacy of resources and lack of access to resources creates problems such as access to the lab by both teachers and students during Computer Studies lessons.

6.2 Rules

There are no specific rules within the school meant to encourage ICT adoption and integration. The school leadership does not have any particular expectations from teachers about using ICTs; the only expectation of the school is for teachers to do their best in their teaching subjects and to help the school in getting a better position nationwide, as the school performed badly in the last national exams.

Findings show that there is no-inservice training for teachers in GSS, no training plan and yet teachers are expected to use computers to prepare students’ termly academic reports.

6.3 Subject

Teachers are change agents and are an integral part of learning. Their expertise is necessary for successful ICT integration processes in schools. Findings show that ICT integration is done mainly by male teachers, except for Computer Studies department. Most of the teachers indicated that they have inadequate ICT skills and this may explain why most of them are not keen to integrate ICTs in their teaching. Observations also reveal that even though some teachers integrate ICTs in their teaching, they are not confident. Younger teachers seem to be keen to use ICTs when compared to teachers with many years of teaching experience. One participant said that “you cannot teach old dog new tricks”. In a nutshell, relatively fewer teachers in GSS integrate ICTs into their teaching subject in a way that motivates students and enriches learning or stimulates higher-level thinking and reasoning. Teachers’ attitudes towards ICT integration is negative as they feel the school administration does not care about their ICT needs.
6.4 Object

Teachers were asked about the most important factors which encourage or discourage them to use ICTs in their instructional activities. Some said that lack of access to ICTs discourage them from using ICTs in teaching and learning activities. Those who use ICTs regularly said they were encouraged by the diversity brought by ICTs into their lessons. Students have been reported to be very active during lessons where ICTs are used compared to lessons where they are not. Computer Studies and Art and Design teachers who have been integrating ICTs into their instructional activities on regular basis stated that ICT integration interests students and keep them involved in the lesson hence, plan on using ICTs. It can therefore be concluded from the findings that ICTs make teaching and learning activities more interesting and interactive hence, the school must make it a point that ICTs are availed to teachers and students.

6.5 Community

Findings have revealed that there is no communication and collaboration among members of the GSS community: students, teachers and the school administration, in ICT integration. It seems that teachers who integrate ICTs into their teaching activities do so because of their interest in using those resources or because of the immense benefits they experience when using ICTs. Some of them have even gone to the extent of using their phones to get information from the Internet as there seems to be a problem with the school Internet. The school administration on the other hand seems not bothered whether there is ICT integration in the school or not.

Teachers also stated in interviews that they do not use social media for academic purposes although most of the teachers agree that social networks could be used as a powerful learning tool since most of the students access them daily and find them interesting. Teachers stated that they do not use their cell phones to communicate with students, let alone sending or receiving text messages. Most of them find it inappropriate and said previously some students misused this gesture and sent inappropriate messages to teachers even at awkward times.

In conclusion, findings have revealed that there is need for the GSS community to work together and to have a common goal for ICT integration. The school could even have an intranet where teachers, school administration and students could have a platform for collaboration.

6.6 Division of Labour

Findings show that students participated actively in lessons where ICTs were used as compared to those where it was not. They discover things on their own, and are able to do mini-researches in their groups (offline) and present them using Power Point presentations. Students worked together in pairs or in groups even in classes where ICTs were not used. Their interaction depended on the teacher’s teaching method and approach. Some of the teachers who clearly stated that they have never used ICTs in their lessons said they could not differentiate the roles of students in lessons where ICTs are used since they have never used them, whereas those who usually use ICTs for instructional activities find students attentive and working on their own instead of depending on the teachers. Most of the teachers said that they become facilitators or coaches when using ICTs instead of their normal traditional role of lecturing.

Generally, most of the lessons observed were teacher-centred whether ICTs were used or not. It was observed that most of the teachers guided students, gave them feedback, and helped them solve problems both in the subjects where ICTs were used and not used.

6.7 Outcome

It was observed that although the same learning content was offered to all students, the content was improved and became more interesting where ICTs were used. Students’ interest and motivation for the subject was increased by ICT integration, which also contributed to the enrichment and interaction of the learning environment. Some teachers stated that ICT integration made their teaching easier, since ICTs made the students acquire the skills to work on their own. They emphasised that ICTs ensured active involvement of
the students in the lesson activities and increased student motivation towards the subject. However, longer observations are needed to find out whether students’ performance is increased by ICT integration in the teaching and learning activities.

7. RECOMMENDATIONS

The school administration must take a leading role in ICT adoption and integration strategies. It must work with the staff and the ICT coordinator to develop and implement an ICT policy for the fair sharing of ICT resources in school. It is recommended that each school should have at least two fully resourced computer labs to allow access to all students and teachers. The school should treat a wireless Internet connection as a matter of urgency in the school so that teachers could practice ICT integration in their respective subjects and classrooms. The bandwidth of the current Internet connection must also be increased to enable fast surfing. The ICT curriculum should also be revised; conventional teaching methods need to be changed, for successful ICT integration in schools. Teachers’ salary should also be increased to motivate teachers and to enable minimum resistance in innovation acceptance. The school should perform an ICT audit, to establish the current status of ICT in a school. It will reveal information regarding the needs, access, resources, use and opportunities provided by ICT within the school.

8. CONCLUSION

The empirical evidence, supported by literature, revealed that several factors come into play in determining whether teachers adopt and integrate technology or not. Personal, institutional and technological characteristics have been identified and found to be factors that often influence teachers’ adoption and integration of ICTs. Lack of access to ICTs was highlighted as a major obstacle that discouraged teachers to integrate ICTs into classroom teaching in this study. It is imperative to give teachers access, and to equip them with the required ICT knowledge and skills to ensure the effective ICT integration into the teaching and learning processes. The school leadership should be more pro-active in being supportive and in designing ICT programs that can benefit the students, teachers, and the whole school at large.

REFERENCES


SOCIAL PRESENCE AND CONTEXT AWARENESS
IN A SOCIAL MEDIA LEARNING ENVIRONMENT

Mashitishi Benson Phurutsi¹, Dumisani Nkosinathi Tsela¹ and Raymond Mompoloki Kekwaletswe²
¹Tshwane University of Technology, Pretoria, South Africa.
²University of Witwatersrand, Johannesburg, South Africa.

ABSTRACT

Underprepared learners and over-populated classrooms characterize most of higher learning institutions in South Africa. Learners in these institutions have varied cultural, educational and social backgrounds, although English is the only medium of instruction. Environment as such leads into a privation of access to learning content and social resources due to fewer opportunities of 1-on-1 interactions with instructors. When learners move away from the classroom learning settings, their on-demand learning challenges cannot be met, especially as they move away from the university premises. On the other hand, the country is seeing more and more learners entering higher learning institutions with a fair familiarity with social media sites such as Facebook, Twitter, YouTube and many more. For this reason, this paper seeks to conceptualize a framework for using social media as a learning environment by analyzing social presence and context awareness in textual interactions amongst learners and knowledgeable peers. The empirical evidence informing the framework was collected in a case study, using learners enrolled in a typical South African university of technology. The study found that indeed a social media environment could be used to leverage the existing challenges manifesting in SA higher education, since learners are already conversant with the said media.

KEYWORDS


1. INTRODUCTION

The prospect of social networking sites has opened doors for researchers to tap into the Ubiquitous Learning (UL) field which sanctions the universities to reflect on their teaching and learning processes. The most popular and used SMS in the globe today is Facebook (FB) ranked first with 845 million active users profile by December 2011 (Facebook, 2012). Although technology has positively affected the way of teaching and learning, higher learning in African countries hasn’t integrated available technologies (Obuobi et al. 2006) to eliminate challenges surfacing in the learning environment. Learners rely on the teacher to access the “know-what” and the “know-how”. With such an approach learning is perceived to be fixed with specific location and instructors. Some learners cannot consult with their peers due to their unique cultures, whereas some are just not well equipped to partake in classroom felt with audience. As a result learners cannot access the learning content or social resources as soon as they move away from the university premises (Kekwaletswe, 2007).

The primary goal of the study was to conceptualize a framework for using social media as a learning environment by analysing social presence and context awareness in textual interactions amongst learners and knowledgeable peers. To achieve this primary goal researchers developed the following questions to drive the study : (1) in what way does the social presence (SP) and context awareness (CA) manifests in a social media environment. (2)How could a social media provide a learning environment? In this study the researchers seek to understand the manifestation of SP and CA indicators on a social media platform used by learners in the institution of higher learning in SA and thereafter use the empirical evidence to conceptualise a framework for social media learning environment. The study used a university of technology in the Gauteng province as a case study. The research participants included first year learners in the faculty of ICT. All the learners were invited to be part of the simulated social media class (a Facebook page) named IT Skills 2012. The Facebook page was named after one of their courses called Information Technology Skill (ITS).
The shifting boundaries of knowledge between the learners and their instructors about the learning content came about during the six months from early January to late June in the year 2012. The rest of the paper is outlined as follows: firstly, the literature informing the paper is reviewed; then the underpinning theories are discussed; thereafter we present the research methodology applied in the study and discuss the findings in conjunction with the conceptual framework. Finally the paper is closed with the conclusion section.

2. SURVEY OF LITERATURE AND THEORETICAL FRAMEWORK

2.1 More Knowledgeable Other (MKO)

According to McLeod (2007) and Galloway(2001) MKO is one of the Vygotsky’ social influences on cognitive development theories referring to any other individual with a better level of understanding than a learner, with respect to the particular task, process or concept. MKO doesn’t necessarily have to be an instructor or someone with a special title; it could be any individual provided s/he can respond comprehensibly from the learner’s questions regarding a specific topic. Galloway (2001) emphasizes that a child’s peer or adult’s children could have a better knowledge or experience on some phenomenon. For learning environment such as TUT where underprepared learners are expected to participate in large classes and English setting environment, the MKO principle can be very helpful. Peers, learners in higher levels or graduates can fill the space of an instructor as an MKO when learners need clarity or confirmation of a subject. With this approach learning is not fixed to formal settings with formal context.

2.2 Learning Environment

Learning environment settings allows interactions and cooperation of learners with their peers and instructors towards attaining knowledge. In the literature it is conceptualized as a psychological, pedagogical and social context in which learning takes place to shape the attitude and learning behavior (Rahman et al., 2012). Since researchers tapped into online learning environment concepts, more and more related entities grouped under this phenomenon were suggested. In the information system field the previous studies suggested E-learning environments, including but not limited to Mobile Learning Environment (MLE); Cloud Learning Environment (CLE); Ubiquitous Learning Environment (ULE) and many more. E-Learning is one of the important development directions of education. It comprises of network and computers used to transfer knowledge between leaners and their instructors through applications such as web based and computer based learning (Yadav and Jain, 2011). MLE refers to settings where learners exercise urgency to manage their own learning through the use of handheld computers (Sha et al., 2011). CLE is referring to responsive and customizable e-learning environments with benefits for learners such as personalization, collaborative learning and self-regulated learning (Mikroyannidis, 2011). Both these extended concepts were instituted with a similar objective of supporting learners without time and place limit for accessing knowledge. These led into the ULE phenomenon. ULE is defined as any settings that allow learners to access learning anywhere/anytime and it is reportedly pervasive and persistent (Jones and Jo, 2004). Learners carry learning with them as they traverse different learning context and they can access it anywhere. Through the context awareness capabilities the ULS environment can detect the behavior of the learners. Unlike the previous researches, this study aim to use the social media platform to suggest a learning environment through and this is accomplished through a proposed conceptual framework.

2.3 Social Media Site (SMS)

The first popular social media sites was Six Degrees (1997); Friendster (2002); Trib.net, MySpace and LinkedIn (all in2003); Orkut and Facebook (2004), YouTube (2005) and Twitter (2006) (Schneider, 2011). Since then, the social media revolutionized the way of communication in life. SMS is defined as one of the “web-based applications that built on the ideology and technology foundation of Web 2.0” and provides a freedom of creating and sharing the user generated content (Kaplan and Heinlen, 2010). Junco et al. (2010) classify social media as a collection of Internet websites, services and practices that support collaboration,
community building, participation, and sharing. There is less education based SMSs application specifically designed to serve as learning and teaching tool in higher education. More commercial social media sites are adopted by higher learning institutions as Learning Management System (LMS) instead of instituting educational based SMS such as NING. NING is one of the social networking sites adopted by universities to serve as Learning Management Software (LMS). It was used in the study of Brady et al. (2010) to explore the educational benefit of Social Networking Site (SNS). The researchers found that the use of NING in education could improve online communication amongst learners in a distance education. The adoption of SNS as a principal approach has improved communication between learner and instructor by expanding dialogue out of classroom or off campus (Harris, 2008). According to Brady et al. (2010), SNS provides flexibility and personal touch when compared to the course management systems (CMS) such as Blackboard.

2.4 Theoretical Framework

The theories of research studies should be adopted with a central aim for analysis, explaining, predicting, or prescribing (Gregor, 2006). This study has adopted Social Presence and Context-Awareness as theories to analyse the practice of social media sites in learning environment.

2.4.1 Social Presence Theory (SPT)

The social presence theoretical framework is the effort of (Short et al., 1976). SPT is classified as the descendant theory of the communication theories (Richardson et al., 2003). It was developed to determine the appropriateness of communication media for varying tasks. It is the combination of intimacy and immediacy. Kekwaletswe (2012) associate Intimacy with communication factors such as eye contact, physical distance, facial expression and personal topic of conversation. Immediacy is a psychological distance between sender and the receiver of the conveyed message (Wiener and Mehrabian as quoted by Tu and McIsaac, 2002). Immediacy could be enhanced by the use of nonverbal cues such as eye contact, gesture and closeness with the instructor. It serves as an indicator to the learners for enjoyment of the course with an instructor (Moore et al., 1996). The reader may wonder how intimacy and immediacy can be achieved in an online environment such as SMS although the sender and the receiver of the message are missing out on the body language and paralinguistic. Within the social media environment intimacy and immediacy could be easily achieved with the use of emoticons or predefined modalities.

This study followed the approach of Rouke et al. (2001) by applying three qualitative categories of social presence (Affective, Interactive & Cohesive) to assess SP on social media learning environment. Affective refers to responses when a person expresses emotions, vulnerability and tease about towards a phenomenon (Swan and Shih, 2005). Interactive refers to the kinds of communication medium that can offer functionalities such as replying, quoting and copying of the content on a medium. Cohesivness is identified through such as phatic and salutations, vocatives and usage of pronounce like “we”, “us” and “our” (Rouke et al., 2007).

This study argues that communication medium is regarded high with Social Presence (SP) if it could provide users with functionality that can match categories such as Affective, Interactive and Cohesive. In contrast low SP on a medium could weaken the chances of being affective, interactive and cohesive and in turn the acknowledgement between learner and More Knowledgeable Other (MKO) will be lost (Tu and McIsaac, 2002). This is the reason this study applied the model and template of Rouke et al. (2007) to examine social presence theory on the social media site when used in the learning environment. This model was preferred because of its simplicity and popularity.

2.4.2 Context Awareness Theory (CAT)

Context-awareness is the ability of a computer application to acclimatise in the current environment and responds accordingly to its users (Bricon-Soufa and Newmann, 2007). The application could only be classifies as context aware if it is capable of sensing it’s physical, task and social situation (Brooks, 2003). This study acknowledges that context-awareness is a theory applied in the computer science for development of applications that are capable of determining the why, what, when, who and where about of its users. Brooks (2003) approached the context awareness implementation through employing the five narrative queries: Who, What, When, Where and Why, to archive the conceptualization of the ubiquitous learning environment. Context is typically characterised as location, identity, and the state of objects, service or
situation around the current situation (Brgulja et al., 2009). The meaning of contextual information is acceptable if it is made of the above attributes of which the third (state of the object, service or situation) can have multiple meanings. State of the object could be referring to its current time registration, global positioning system coordinates, motion, speed, expiration and so on. The narrative queries can be used to underpin the following fundamental components of Context-Awareness, as identified by Brooks (2003): Temporal Awareness—acquiring of date and time (when) within the context; Location Awareness—Determining the name of the places the user is located at that pointing time and date; Task Awareness—Refers to what the user is doing and Identity Awareness—Determining and managing the who (Brooks, 2003). The promise of context-awareness applications in the learning environment is yet to be a realised. There is a very few applications developed specifically for education purposes in the literature. According to Schilit, Adams and Want (1995), Context – awareness applications have the potential of examining one’s current environment and reacts to his/her changing context. Though the FB could be the revolution in the communication medium, one important aspect which most researchers haven’t explored is the limit on context-awareness (Joly et al., 2009). There is very little information around this area in the literature. Context-awareness is a fundamental aspect of learning more especially in environment where learners are mobile (Kekwaletswe, 2012). When implemented well in the learning environment, the context-awareness application can achieve a handful. It holds a potential of providing learners with the right information at the right time.

3. RESEARCH METHODOLOGY

The Interpretivist research paradigm was followed to understand the phenomenon through the meaning that people assign to them. Qualitative research opinion was drawn from the view of Dawson (2002) who defines it as a process where researcher undertake methods such as interview or focus group to explore attitudes, behaviour’s and experiences of the participants about the phenomenon. Case study was used in this research for its potential of allowing the researcher to amass qualitative data in a multiple sources and techniques in data gathering process (Maree, 2007). The research data collection took place by means of one-on-one interviews and the analysis of textual interactions recorded on the simulated class. Interview questions were formulated around the research questions of this study. An open question followed by theory driven and hypothesis-directed questions were asked and ended with probing questions. The participants were not limited to respond in a particular manner that suites the researcher’s pre definition of phenomenon, instate participants were set free to respond to question based on their immediate know how. More than 200 leaners accepted the invitation to enrol on the simulated class. Because of the character of social networking the text interaction took place were automatically recorded as the learners engaged in the authentic tasks. This text cues were later regarded as the transcript and subjected to analysis. The analysis of textual interactions was employed with the aim of providing secondary extra data confirming experience, attitude or behaviour that research participant’s claim in their interview response, likewise in the qualitative research methods (Flick, 2009).

The study used the content analysis to assess the social presence and context-awareness indicators on a social networking sites environment. Content Analysis is a research data analysis method used to study contextual meaning of the data (Hsieh and Shannon, 2005). This means the researchers construct the meaning of data (recorded communication) found in documents (Dane, 2011). For this study the researchers used one of content analysis categories discussed in the next section to code and identify SPT & CAT indicators within the transcripts. There is three content analysis categories used by the Interpretivist purists to analyse research data, namely: Conventional, Directed and Summative (Hsieh and Shannon, 2005). Conventional content analysis focuses on developing a meaning of the phenomenon through the coding categories generated within the text. Directed content analysis uses the adopted underpinning theory as a starting point to generate the coding categories. Summative content analysis is done through counting and comparing the key words found in the transcripts. Therefore, this study adopted SPT and CAT Indicators in a directed content analysis to understand ways in which SP and CA manifests in a social media environment. Thereafter the researchers used the empirical evidence to conceptualise a framework for social media as an online learning environment.
4. FINDINGS AND CONCEPTUAL FRAMEWORK

4.1 In what way does Social Presence and Context Awareness manifests in Social Media Environment

To address this research question the researchers looked for the indicators of both the theories (social presence and context awareness) in the amassed empirical evidence from the recorded communication (simulated online class text cues and learners interview transcript). This study found on one hand that social presence surfaces through the usage of predefined modalities of the social networking sites and those that are defined and accepted by the social media community. On other hand the context-awareness takes place manually based on the user contextual commands and automatically through contextual reconfiguration on the awareness indicators such as location and temporal respectively. For example, it was found in the interview responses and text cues that when learners agrees on something they resort to usage of modalities such as ‘Like’ button or emoticons such as happy face ‘☺’ or thumps up ‘&’ to express their acknowledgement on subject discussed on the social media learning environment. For CA indicators the study found that every text posted in social media is automatically attributed with contextual details such as place more especially when mobile device is in use and location detection is enabled. The time stamp is also indicated on the post with the automatic attribute such as ‘Now’, ‘an hour ago ‘Yesterday at 8.52’. These indicators of SP and CA in a learning context help learners acknowledge information or instruction from a Peer, MKO or Instructor. Learners also get to know who is within their learning spaces.

It is found in the empirical evidence that Facebook allows learners to express their feelings (Affective), discuss their outside classroom life activities and share the sense of humour on an online simulated classroom. Learners mentioned in the interview that they can share (Interactive) their feelings on FB. This was evident with the text cues such as “guys we have to study which chapters exactly for the semester test?????? #confused” or “I’m tired of reading datbuk CGS 10AT 11 chapters and millions pages ha!” Learners simply use the “share” button to explicitly refer to others messages. Through texting they ask questions on the social media environment at any given time because FB gives them the sense of presence of Peers/MKO/Instructor. The FB environment does allow its users to add the profile names of those they are referring to (Cohesive) in their communication. It is a simple mechanism of which is auto completed as the user types in the first few matching characters. It is also evident that learners use the inclusive pronouns such as ‘we’, ‘us’ or ‘our’ which gives them a sense of belonging in a community of enquiry. The identity awareness comes easy because learners and MKO/Instructors have created the profiles with names they prefer to be addressed with and pictures representing them. All these profiles have personal details such as home address, pictures, mobile phone number, interests, religious views and data like relationships that helps them identify other peers or even the MKO/Instructor. Through social media environment the learners get to know what is happening around them because they postulated that their online friends have a tendency of publishing their current tasks context (Task Awareness) wherever they are. This study has found that indeed a social media environment has a high SP and CA and it could be used to leverage the existing challenges manifesting in SA higher education since learners are already conversant with the said media. The following section discusses the conceptual framework for social media as a learning environment using SPT and CAT.
4.2 A Conceptual Framework for Social Media as a Learning Environment

In figure 1 the researchers illustrate the conceptual framework for social media as a learning environment for higher learning institutions in South African context. The framework is illustrated through dotted lines to elucidate that these concepts happen in the human mind. In the illustration the largest oval represents a social media environment. Within the social media environment the researchers depict two role players namely: the Learner and the MKO. According to the data analysed herein learning in higher education institutions can take place between two persons. There is always one person who needs to consume the content and the other who can provide clarity or knowledge regarding the learning content. The person representation on the far left of the illustration epitomizes the learner interrogating the learning content. The MKO depiction on the far right of the illustration represents any individual in a learning environment with a better understanding of a certain phenomenon that the learner is interested in consuming. Both the role players could be in any of the learning contexts: Formal, Semi-Formal and Informal. Meaning through social media, learning could happen anywhere/anytime either in the office, home, classroom, garden, public transport or at the party. The dots in the head of two depicted persons are an exemplification of the knowledge towards a phenomenon. Meaning the learner is someone with little knowledge of a specific phenomenon compared to MKO. In the dotted overhead oval the illustration represents high Context Awareness and Social Presence in a social media environment. The lines from the head of both learning role players depict the awareness of context and social presence in their heads. During the analysis it was uncovered that the SP can surfaces through the usage of predefined modalities and that the CA takes place manually based on the user contextual commands and/or automatically through contextual reconfiguration.

This enhances learning in a way that a learner would be able to source for assistance on social media environment through identity awareness when working in isolated learning spaces such as home. Through this conceptual framework the learner would be aware of the availability of the more knowledgeable others; the locations of their MKO; awareness of their peers’ moods (whether they are excited or sad), awareness of the temporal context such as time and date; and the awareness of who of the location of MKO for assistance when an on demand learning challenge prevail. The indicators of social presence would be very prevalence through the expression of affectionate using social media modalities such as emoticons (sad/happy faces). Due to the ubiquitous manner of the social media sites the interactions of the learners and the MKO will be frequent and the learners will appreciate the immediacy and the intimacy from their MKO. This should give the sense of the community of enquiry to the role players of learning. Role players should perceive themselves as one and united in this environment. Consequently learning will be enhanced and accessible anywhere/anytime because of the richness of social presence and context awareness on social media environment.
5. CONCLUSION

In this study we explored the textual interactions to analyse how the SPT and CAT theory manifest between learners and MKO in a social media environment. After understanding the manifestation of these theories in such environment we conceptualised a ubiquitous learning support for SA Higher Learning.

The work of Schlageter (2006) about e-learning in distance education - towards supporting the Mobile Learner should be extended as a future work to social media support in a blended learning environment - towards supporting the underprepared Learner in SA context. The information system theory such as activity theory network should be adopted in the future studies to determine activities that are suitable for learning on Social Media Sites.

REFERENCES


JUNCO, R., HEIBERGER, G. AND LOKEN, E. 2010. The effects of twitter on college student engagement and grades. Journal of Computer assisted Learning, 27(2)


DESIGN AND DEVELOPMENT OF A MASHUP-BASED APPLICATION TO SUPPORT ORGANIZATIONS' COMPLIANCE TO ISO27001

Marina Gavrilaki¹, Angelika Kokkinaki¹ and Ioanna Dionysiou²

¹Open University of Cyprus - P.O. Box 12794, 2252 Nicosia, Cyprus
²University of Nicosia - P.O. Box 24005, 1700 Nicosia, Cyprus

ABSTRACT
This paper presents the design and development of a mashup application that examines compliance of any given organization to ISO 27001 security guidelines. The described application performs a gap analysis, identifies relative strengths and weaknesses, collects relevant information and proposes specific recommendations to overcome security inefficiencies. The need for developing such a system has been substantiated by a survey that had been conducted in Greece and Cyprus and identified that, security mechanisms and the management of IT resources ought to be improved on a number of aspects.

KEYWORDS
Security, ISO27001, Mashup

1. INTRODUCTION
There is an emergent need for enterprises to protect their resources and assets by taking all necessary measures to prevent, detect, and recover from security attacks (Stallings, 2010). At large, IT security strategies are perceived to require high investment in ICT infrastructure and resources; furthermore, their implementation and follow up are considered to demand highly skilled human resources.

ISO 27001, the Information Security Management System (ISMS) standard published by the International Organization for Standardization (ISO) provides a framework to promote assurance that the management system for information security is in place as it specifies "the requirements for establishing, implementing, operating, monitoring, reviewing, maintaining and improving a documented Information Security Management System within the context of the organization's overall business risks" (ISO, 2005). Compliance to ISO 27001 does not guarantee that the organization will never experience any security exploitations; though it does assure that the organization has taken protective measures to avert security attacks and in this respect it has lowered the risk of interruptions during business conduct.

Surveys conducted in Cyprus (Dionysiou et al., 2012) and Greece (Gavrilaki, 2012) revealed that many organizations neither follow ISO 27001 nor do they have a self-assessment mechanism to examine their level of compliance to ISO27001. The situation is even more conspicuous among Small and Medium size Enterprises (SMEs). The surveys enlightened a number of interesting realities regarding the deployment of security services, which are compliant to ISO 27001. In general, the presence of an IT department has a significant impact on the approach a company has towards security practices. Companies with a dedicated IT department tend to have significantly more security procedures in place. Still, even in these companies there are unaddressed security issues and they are far from being regarded as implementing best security practices. Although security breaches happen in all companies, their detection rate is significantly higher amongst companies that have an IT department. However, it was observed that there is a hesitation to report incidents of electronic sabotage, denial of service, theft of proprietary information, fraud, and any form of embezzlement. The non-disclosure of security violations is a common practice; it could be attributed to the financial implications and the impact on organizations’ credibility if such incidents become public knowledge. It should be outlined that some companies still lack antivirus software, firewalls and proper password management.
Furthermore, many of them claim to have certain protocols in place (e.g. disaster recovery plan), but in most cases, these have never been tested or updated. Based on the survey results, it is evident that a very limited number of companies could obtain an ISO 27001 certification.

Based on the above, a need has been identified; a need for a service that would assist enterprises to make assessments on their level of compliance to ISO 27001 and provide recommendations on aspects that need improvement. Such a service could also raise awareness on ICT security overlooks and possibly contribute to reconsideration on ICT security policies and followed practices. For this purpose, an application was decided to be developed taking advantage of enterprise mashups. This decision was not simply an action reflecting a recent trend. Rather, in accordance with Fuchsloch et al. (2010) it was viewed that this was a cost-effective way to empower the involved stakeholders and their long tail needs by reusing existing software artifacts and provides a mechanism that is self-selected and decentralized rather than hierarchically assigned (Benker, 2006). The developed service is a proof by example that the design and implementation of an effective security strategy in organizations does not have to be demanding in terms of ICT infrastructure and human resources.

The remaining of the chapter is structured as follows: Section 2 presents an overview of mashup architectures. Section 3 describes the design and development of the system and section 4 concludes this paper with recommendations for future development.

2. LITERATURE REVIEW: MASHUP ARCHITECTURES

An Enterprise Mashup may be defined as a Web-based resource that combines existing content, data or applications, from one or more providers by empowering the actual end users to create and adapt individual information centric and situational applications (Hoyer et al., 2008).

Enterprise Mashup applications combine simplified concepts of Service-Oriented Architecture (SOA) with the principle of peer production (Daniel et al., 2007). The relevant architectural components of the Enterprise Mashup paradigm are Resources, Widgets, and Mashup applications (Hoyer et al., 2008). Resources may be content, encapsulated via well-defined public interfaces (i.e. WSDL, RSS, Atom). The layer above contains widgets, which provide simple user interaction mechanisms abstracting from the complexity of the underlying resources. Widgets are developed by consultants or key users in the business units who understand the business requirements and know basic development concepts. Finally, end-users with no programming skills are able to combine and configure such visual widgets according to their individual needs, which results in an Enterprise Mashup.

Maximilien et al. (2008), Yu et al. (2008), Hoyer et al. (2008) refer to existing research efforts that focus on development tools and underlying technical concepts and principles in the mashup domain. Fuchsloch et al. (2010) note that current cross-organizational integration is handled on three levels: sata, application and processes (Linthicum, 2001). With the introduction of enterprise mashups, users evolve into an additional level of cross-organizational integration (Minsk et al., 2007).

Mashups aim to address all the above and also harness the knowledge of users. Business transactions are executed by users who know the requirements and business processes. However, users are currently left out from the discussions (Minsk et al., 2007). Users are constantly aware of the changing environment to make decisions. The implementation on SOA-based architectures is not designed for such use cases, as it requires developers who are expensive and have been sourced externally by SMEs.

In particular with respect to the involvement of end-users in ICT security safeguarding, researchers and practitioners (Bagchi and Udo, 2003; Baskerville, 1993; Dhillon and Backhouse, 2000; Liang and Xue, 2009; Loch et al., 1992; Stafford and Urbaczewski, 2004; Straub and Welke, 1998) have proposed models for end-user involvement and practices of excellence in ICT security safeguarding that prevent potential harm and losses from ICT security bridges. From this perspective, important questions are: who is involved in ICT security management, what are the roles of the different stakeholders, in particular of the ICT administrators and end-users in the various business units, what procedures must be followed for ICT security, how compliance with procedures is ensured, what are the contingency plans and what are the necessary processes to enable and sustain users community participation.
3. DESIGN AND DEVELOPMENT OF THE MASHUP APPLICATION

The mashup application is based on the framework described in the previous section. It has been designed in a way that it addresses those issues that had been highlighted by the conducted surveys (Dionysiou et al., 2012, Gavrilaki, 2012). More specifically, the mashup application supports the following functional specifications.

1. The mashup application provides a variety of different self-assessment instruments, which are formed as online questionnaires. While users answer the questions they not only log the deficiencies that exist in their IT systems, but through the process they become aware about ICT security requirements and recommended practices.

2. The mashup application performs a gap analysis. Based on the users’ answers on the ICT security practices followed in their organization and the recommended best practices in the context of ISO20071, the mashup application calculates and presents a graphical interface for the given organization ratings in each of the main ICT security aspect. In addition, the system presents the correct answers to the questionnaire, compares the users’ responses, rates the existing level of security and, then, provides recommendations / suggestions for improvement to address deficiencies.

3. The mashup application introduces useful and relevant information on ICT security in two directions: a) it collects updates on current threats, articles, seminars, lectures, etc. and b) it employs RSS to display information relevant to the topics raised by the gap analysis that the responses draw.

Table 1 presents the overall outline of the instrument used for the gap analysis.

<table>
<thead>
<tr>
<th>Section</th>
<th>Questions</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Profile</td>
<td>12</td>
<td>IT department structure (if any), company demographical and personal data</td>
</tr>
<tr>
<td>A - Network Details</td>
<td>11</td>
<td>Network topology and connectivity, security concerns, security technologies deployed, current security practices, various security incidents</td>
</tr>
<tr>
<td>B - IT Security Management</td>
<td>15</td>
<td>Objectives defined, human resources allocated, action plan documented and implemented, ongoing training of old and new personnel, etc.</td>
</tr>
<tr>
<td>C - Security of IT Systems</td>
<td>14</td>
<td>Protection mechanisms used, roles and profiles assigned to users, privileges and permissions etc.</td>
</tr>
<tr>
<td>D - Compliance with Security Requirements</td>
<td>6</td>
<td>Confidential information storing, security regulations monitored, reported security breaches etc.</td>
</tr>
<tr>
<td>E - Networking and Internet Connection</td>
<td>7</td>
<td>Firewall existence, configuration and functionality monitored etc.</td>
</tr>
<tr>
<td>F - Maintenance of IT Systems</td>
<td>3</td>
<td>Update management, test concept for software modifications etc.</td>
</tr>
<tr>
<td>G - Passwords and Encryption</td>
<td>6</td>
<td>Password protection and encryption, concerns on mobile ICT equipment etc.</td>
</tr>
<tr>
<td>H – Contingency Plan</td>
<td>3</td>
<td>Contingency plan existence, familiarity and accessibility etc.</td>
</tr>
<tr>
<td>I - Data Backups</td>
<td>5</td>
<td>Strategy, implementation, control and updates, documentation etc.</td>
</tr>
<tr>
<td>J - Infrastructure Security</td>
<td>5</td>
<td>Adequate protection against physical threats, sensitive areas physical protection, visitors protocol, intruders’ protection, etc.</td>
</tr>
</tbody>
</table>
The information harvested in this way offers a clear picture regarding beliefs, needs, deficiencies and user expectations and indicates the level of response on ICT security in every organization that participated in the surveys.

The application developed, aims to increase awareness on insufficient ICT security measures, the complexity of the subject, the risks and their consequences and insights on the subject of ICT security. It is not intended as a fully qualified tool for educational and training reasons or for pointing out all possible risks and solutions. The target audience for this service is not senior, fully trained staff in Computer Science, like ICT Security Officers. Instead, this application serves end-users and/or ICT administrators who are not experts on the subject and do not have the financial nor technical resources for implementing ICT security measures. Despite these limitations, they seek ways for: i) comprehensive acknowledgment of the ICT security measures shortage (gap analysis) mainly towards organization’s Senior Management, ii) initial, rapid and timely updating, iii) human resources awareness and vigilance and d) strengthening existing practices.

At the same time, the application attempts to show that despite the numerous shortcomings in countermeasures, in information and awareness, in human, financial and technical resources, what is really required is the commitment of the Administrations of the organizations in terms of security, while no exaggerations and excessive costs are needed.

The final decision of using mashups as an auxiliary tool for complying with international ICT security standards was not based only on the fact that they consist an innovative architectural approach. Mashups are superior in comparison to the traditional application development. In summary, the development time is much shorter, there is flexibility according to the requirements and actual needs, the focus take account of the user community and produces ad-hoc solutions to meet immediate needs (Hoyer and Staneovska-Slabeva, 2008). Besides, this application belongs to the small e-projects class (Pressman, 2005), where an agile approach is required, with reduced in emphasis and intensity development processes. The comparison of the characteristics of mashups (Carrier et al., 2008; Hoyer and Staneovska-Slabeva, 2008) to the characteristics of small e-projects (Pressman, 2005) highlights the matching of objectives and needs. If traditional development were used, then the procedure would require more time and resources, and the result would be "heavy" for this type of application. This approach was proven right by the evaluation results as described below.

The selection of the mashup tools to be used for the development of the application was based on a number of assessment criteria (Hoyer and Staneovska-Slabeva, 2009; Pontikis, 2008):

1. Target: consumer, enterprise or data mashups.
2. Technology:
   • RSS or/and Atom feeds processing (as most widespread),
   • support of web services, and
   • capability of using programming languages, such as JavaScript.
3. Installation type: concerning installation time and degree of difficulty. This criterion is particularly important when the tools are intended for private use or for small (or micro) organizations.
4. Acquisition cost of the platform (if not free).
5. Input and output types which are supported; a mashup is very likely to need to work with other applications of the organization, such as databases or ERPs.
6. Number of supported features; such as the number of available widgets.
7. Effective error handling mechanism (debugging).
8. Documentation provided: a comprehensive operation manual of the platform with sufficient number of indicative applications available.
9. Allowing the user to store the mashups he builds in his own website; this is particularly important because some platforms allow publication of mashups only on the website of the manufacturing company or through a development platform, without allowing the user to use them wherever and however he wants, thus limiting their usefulness considerably.

According to the above criteria, Dapper, Kapow, FAST, Karma and IBM Mashup Center were rejected from the beginning. A comparative analysis has been completed for: Presto Enterprise Mashup, Yahoo! Pipes, WSO2, iGoogle and Netvibes. Presto Enterprise Mashup has been selected because it is free, it is both cloud and desktop based, it employs the prototype language EMML by OMA and is an integrated platform with multifaceted support for mashup creation, editors to develop code, GUI interface etc. The mashup application was developed based on PHP, JavaScript/JQuery and Apache. The EMML language was used, and the produced mashups were hosted in a Presto Mashup Server Enterprise. The mashup scripts written in EMML are translated by the Mashup Server at runtime. It was decided to have three different self-assessment tools.
The first is a complete checklist that examines compliance with the ISO27001; the second addresses the security aspects in various departments/units within an organization and the third focuses on certain issues of ICT security (i.e. threats, networks, human resources), as presented in Figure 1.

![Selection of Self-Assessment Tool](image)

**Selection of Self-Assessment Tool**

- Full Assessment (according to the standards ISO/IEC 27001, 27002 and 27005) (Estimated time: about 20 minutes)

**Targeted Assessment about:**

- ICT Unit (Estimated time: about 15 minutes)
- Security Policies (Estimated time: about 12 minutes)
- Contingency Plan (Estimated time: about 12 minutes)

**Security Management about:**

- Threats (Estimated time: about 16 minutes)
- Networks (Estimated time: about 10 minutes)
- Human Resources and Security (Estimated time: about 10 minutes)
- Risk Analysis (Estimated time: about 15 minutes)
- Software Security (Estimated time: about 10 minutes)

Figure 1. Self-Assessment tools for ICT Security within organizations
Upon selection of a self-assessment tool, a form is presented to the user that needs to be completed dynamically, as shown in Figure 2. The results of the self-assessment and the gap analysis are presented to the user both in textual and graphical way, as shown in Figure 3. The textual description of evaluations consists of positive and negative comments, classified into three levels depending on the severity of the issue identified.

Figure 2. Screenshot of the Self-Assessment tool for security practices
Figure 3. Graphical interpretation of security assessments per category

Useful Information

Figure 4. Security recommendations and relevant content gathered by the mashup
Furthermore, the application “mashups” news and developments on the topics that are relevant to the answers given by the user during the assessment, as shown in Figure 4. Gathering RSS content from multiple (public and private) organizations engaged with ICT security, it gives the user, relatively quickly and easily, news, alerts, publications etc. The application constructs search terms pursuant to the answers given by the user and then applies them to the obtained content to present the result, accordingly.

Emphasis was given to web standards compliance (browser compatibility, accessibility, SEO, usability), as well as to simplicity, ease of use and navigation. Several appropriate tools were used to evaluate its functionality (SortSite, Qualidator Site Analyzer, W3C Validation etc.). Moreover, the application provides a set of templates that could be used as supporting documentation for the compliance with the ISO27001 standard. There is a section on Frequently Asked Questions regarding security and a glossary. Currently, the application is in Greek and English. Formal evaluation of the mashup application is being conducted. Finally, at the level of elaboration of compliance with ISO 27001, more research is planned in the future to address technical issues of the mashup deployment and requires elaboration of ISO27001 compliance system implementation.

4. CONCLUSIVE REMARKS

This paper presented a mashup application which aims to support the adoption of ICT security policies and raise awareness on ICT security. Currently, it is hosted on the servers of the Open University of Cyprus. The innovative point of this idea as well as its distinctiveness is that it provides the most easy access to ICT security issues to end-users (being an open source web-based tool) who now can be acquainted and check out the ICT security procedures used within an organization. End-users and/or administrators with no specialized knowledge can note where they can contribute, which incorrect actions or decisions they make, how to correct erroneous acts and behaviors. ICT security issues get increased visibility and considerations are raised related to followed practices that fall short of recommended standards, leading involved parties to become responsible for their actions or omissions.

This application can be further enhanced and improved in the following directions. A benchmarking mechanism can be developed and incorporated: the answers to the self-assessment tools can be saved in databases and each user's answers may be compared to the mean values of other users in the same sector. The mashup application may also be used as assistive to an e-learning project, that will include specific instructional scenarios for ICT security concepts in general and the accreditation process in compliance to ISO27001. Finally, the application may be used to support security requirements in specific services domains, i.e. tertiary education institutions, health units and hospitals and legal agencies.

REFERENCES


Short Papers
ANALYZING IT IMPLEMENTATIONS

Alina Andreica
Faculty of European Studies, Babes-Bolyai University
Cluj-Napoca, Romania

ABSTRACT
The paper focuses on IT – information technology – implementations analysis, in particular information system analysis, by giving a general framework and specific guidelines for various organization types from the IT management point of view. Such analyses are important in order to evaluate the efficiency and especially appropriateness of various information systems implementations. An elaborate case study is performed on Babes-Bolyai University’s global learning portal and information systems for academic, research and administrative management. The global UBBoonline portal provides both e-learning facilities and facilities for integrating the dedicated information systems. We also present students’ feedback regarding educational facilities available within UBBoonline portal.

KEYWORDS
IT management, information system implementation & analysis, e-learning, academic portal

1. INTRODUCTION
Information system analysis and design is an essential topic in software development (Whitten, Bentley, 2007), (Kendall, 2008), various principles being described in this respect. Information system analysis can also be dealt with from a formal point of view (Wand, Weber, 2008).

The present paper proposes an interdisciplinary approach, combining IT and management perspectives, and proposing, in this framework, general guidelines for analyzing specific IT implementations, synthesized from the author’s 10 years of research, theoretical and practical experience as IT manager within Babes-Bolyai University – BBU, Cluj-Napoca, Romania. The analysis case study is performed on BBU information systems that have been implemented: the dedicated systems for academic, administrative and research management, as well as the global e-learning portal which integrates them within a single sign-on architecture. Section 2 addresses the concepts of IT strategy and implementation, their design principles and characteristics in organization evolution, proposing as well a guideline for information system analysis from an IT management point of view. Section 3 explains the compliance of BBU’s IT implementations with its goals and requirements. Section 4 addresses UBBoonline portal facilities both from a technical and from the users’ points of view, while section 5 presents the student feedback consequent to using the portal’s e-learning facilities at class. Conclusions reveal the most important contributions of the paper.

2. IT STRATEGIES AND IMPLEMENTATIONS
We consider that IT management (Andreica, 2009) has to be integrated within organizational management since, on one hand, it should address the organizational goals, which should be explicitly expressed, and, on the other hand, since it should be provided with appropriate resources – human, financial, even implementation time. An organizational IT strategy comprises the following levels: 1 infrastructure – computer, servers, network connection – provided either within the organization premises or in the cloud (Mell, Grance, 2011); 2 basic software – operating systems and commonly used software: office automation, Internet information and communication, optionally database processing – either installed on the organization’s computers, or in the cloud, as on-demand services; 3 dedicated information systems – they usually cover the following areas: organizational activity management, such as ERP systems (Kendall,
2008), web sites, portals, e-commerce systems (Andreica, 2009), specific software dedicated to the activity target field – for example: e-learning software for training companies, legal / judicial systems for consultancy companies, computer assisted design for production companies, etc.

Any IT strategy (Andreica, 2009) should be adapted to: the organizational goals and target field, the organizational resources – human, financial; the management style & strategy, which may as well influence the resources that are provided, by allocating necessary resources.

**Information systems** – top of the IT strategy, have to pursue specific implementation stages in order to reach their organizational goals (Andreica, 2009). Users have to be involved mainly in the analysis and testing phases, as well as in the usage ones; we note that is important that these stages be appropriately managed on the users’ side. Information system evaluation should take into account: requirement compliance, security requirements, a good quality/price rate, global acquisition, training and maintenance costs and terms (Andreica, 2009).

We further reveal the main IT features of organizations or companies in their evolution.

**Small companies**, which have main promotion goals, fulfill them by implementing a promotion web-site (Andreica, 2009), with moderate costs and important promotion advantages. If the web site content properly addresses the promotion goal, the web site brings important marketing advantages, new clients and leads to increasing the company’s turnover (or popularity, for non-profit organizations). Simple accountancy programs or externalized accountancy services are used in order to manage the company’s activity.

**Medium companies** (Andreica, 2009), with a well consolidated market (or societal) position, and aiming at improving it, develop web-sites with client (visitor) communication and feedback facilities, and may develop towards a portal or an e-commerce web site. These organizations may acquire dedicated software for their specific target field. Regarding their activity management, they should begin the implementation of an integrated ERP system in order to manage the company’s activity. They also require dedicated IT personnel; the IT compartment begins with a system engineer and further develops.

**Large companies** are characterized by a complex activity (Andreica, 2009), therefore leading to complex IT strategy; their activity management is performed by means of an integrated ERP system, which makes available on-line information from any compartment and to decision assistance facilities for the management levels. Without such a system, practically the organization’s activity would be unmanageable since it would require too much time, and wouldn’t be able to ‘survive’ on the market. Their web site has been developed into a complex web portal, providing proficient facilities to the clients. Dedicated information systems have to be acquired in order to sustain the company’s development on its target field. Regarding human resources, they already have a well consolidated IT department, and its IT management has to be integrated into the company’s organizational management (Andreica, 2009).

Based on the information systems implementation and analysis background, we recommend the following **guidelines for an information system implementation analysis** from an IT management point of view: organization goals and brief organization description – size, resources – this section is necessary in order to evaluate if the IT implementation is adapted to the organizational characteristics; IT implementation characteristics – there should be addressed organizational and user oriented issues, besides technical ones; organizational functionalities and user perspectives are very important in order to evaluate compliance to specific needs; in this respect, various user categories may be interviewed or involved in dedicated surveys; a system impact evaluation is also useful; deducing potential problems from the above mentioned analysis; proposing solutions for the above stated problems; foreseen impact of the proposed solution, from the organizational management point of view, underlying the organizational change induced by the system.

### 3. SYSTEM ARCHITECTURE, COMPLIANCE TO INSTITUTION NEEDS

Babeș-Bolyai University http://www.ubbcluj.ro – UBB – is the biggest and one of the top Romanian academic institutions, placed constantly and especially during last years in the top of national rankings from the point of view of academic and research outcomes. Nowadays, the university is the most comprehensive in the region, with 21 faculties, 10 extensions in the territory and 2 foreign language centres; its activity being supported by over 1500 academics, 285 researchers and 1125 employees in the administrative and technical offices, and trains over 53,000 students, providing 248 programmes of study in Romanian (BA and MA), 94 programmes of study in Hungarian, 19 programmes of study in German, 36 programmes of study in English,
and 9 programmes of study in French. The multicultural profile of the university is one of the important features of our institution, promoting multi-culturality being one of its main missions. In the field of scientific research, UBB’s strategic orientation for strongly sustaining research activities has begun since 1998-2003; in the last years, UBB has been appointed as an advanced research university at a national level.

Taking into account its resources, the dynamic character of the education field consequent to the educational reform, UBB has decided to develop its own information systems, process which has taken around 8-10 years. Presently, there run three integrated information systems, which address: academic management – AcademicInfo system (Andreica et al, 2011), research management – Research Management system (Andreica, Agachi, 2008) and administrative management – ManageAsist system (Andreica et al, 2009). A global e-learning portal UBBonline has also been developed in order provide integrated e-learning facilities and to integrated the dedicated information systems (Andreica et al, 2011).

The arguments for its architecture and design principles are further given. Aiming at implementing a global e-learning portal, compliant to our university’s multicultural, and autonomous organizational culture, we have chosen a flexible e-learning solution. E-learning systems may have pre-defined facilities - like Blackboard (Blackboard web) or WebCT (WebCT web) or more flexible facilities – like moodle (Moodle web) or MS Learning Gateway (MS Learning Gateway web), the latter having increased flexibility and integration advantages, including integration ones by means of the Identity Lifecycle Management server.

Moreover, we aimed at choosing a framework which would also solve our system integration and database synchronization problems (and from an IT management point of view also compliant to the existing MS Academic Agreement); therefore we have decided that the portal implemented for integrating e-learning and dedicated information system facilities to be based on ILM technology. The portal architecture is being described in (Andreica et al 2011), (Andreica et al 2012).

4. GLOBAL PORTAL FUNCTIONALITIES

We further describe the technical facilities provided by UBBonline portal, which solve issues regarding system integration and database synchronization, as well as the facilities dedicated to various user categories.

System oriented functionalities: the portal provides, besides e-learning facilities, an integrated architecture for synchronizing the three dedicated systems databases and integrating the dedicated information systems facilities into one single sign on framework – see (Andreica et al 2011), (Andreica et al 2012). The portal technology has been chosen in order to provide, besides efficient synchronization capabilities, long-term and administration benefits, such as flexibility, extensibility with new components.

The synchronization process runs daily. First run time was around 7 hours, while current updates daily vary from 7 seconds to about 30 minutes, in respect with the updates that are performed on the databases. A full permission restoration procedure, which sets single sign on permissions for ILM server, based on data provided by the dedicated systems (human resources, students, contract studies, etc.) runs daily, taking around 8 hours (Andreica et al 2012). Access to dedicated information systems’ facilities is performed within portal single sign on (Andreica et al 2012). Permissions are checked from the global database, where they are collected from the human resources organization chart and updated daily, as previously described.

User oriented functionalities: UBBonline portal https://portal.ubbcluj.ro provides specific e-learning facilities and dedicated information system ones, for various user categories: students, teachers, research staff, secretariats and administrative employees, academic management, administrators.

1) E-learning functionalities: the web-based e-learning facilities provided by the described portal are the SharePoint (MS SharePoint web) built in ones, adapted to our specific needs, and include: content management and sharing, schedule management and sharing, communication facilities (Andreica et al 2011), such as: e-mail – OWA type, discussion lists, etc., evaluation tools and feed-back facilities; task management, blog and RSS tools, survey tools, as well as other functionalities. The system is also open to adding new web-parts, services or components. Specialization (public access) and discipline (private access) are automatically created based on specific templates and information provided from AcademicInfo.


2) Dedicated information systems functionalities include: academic information management AcademicInfo http://academicinfo.ubbcluj.ro/Info (Andreica et al, 2011), administrative management
The dedicated information system implementation, as well as the global portal implementation had a huge organizational impact and even lead to certain workflow changes. The ManageAsist system for administrative management strongly increased activity efficiency by electronically modeling document and administrative processes, ensuring single entrance of primary documents and modeling their processing within various compartments. Operational activities became easier, yet with an increased responsibility degree (first implementation months, passing form independent programs to an integrated system, were characterized by a certain degree of reluctance regarding the system and its advanced facilities, like pre-registering accountancy operations and the new interface style and its increased transparency in operating, and ‘transferring’ information between compartments); nevertheless, in a short time, users concluded that the system is easier, faster and much more efficient that previously used solutions. The system even modified certain activity workflows, by making them proficient. At a management level, it displayed, even from its early implementation stages, huge advantages regarding on-line information on processings performed in any compartment.

Research management system had a huge user impact since it was the first information system widely used by all academic and research staff, including PhD candidates. Training was an important stage in the system’s implementation. Soon, the system proved its efficiency in globally collecting all research activities at the university level, and making available, at any time, relevant syntheses at department, faculty or university level. Moreover, research activity reporting to national research bodies, which evaluate research activities as a quality indicator for universities’ budgeting, became automatic and therefore very efficient.

AcademicInfo system brought important advantages for students and teachers, making available on-line all necessary information regarding curricula, disciplines, grades, fees. The most difficult part in the system’s implementation regarded the completeness of information entered within secretariats, since students do not have information available unless their contract studies are validated (or entered into the system), and teachers do not have course information available unless they are marked for the courses they deliver. Nevertheless, the system’s benefits became very obvious in time.

UBBonline portal is automatically provisioned with information from the dedicated information systems: human resources and organization chart from ManageAsist, students, curricula, disciplines, grades from AcademicInfo system, research projects from Research management system. Its integration and communication facilities proved to be extremely efficient and useful for various user categories. Nevertheless, its usage is still in fairly early stages, and has to be promoted on a larger scale since its current users, especially students, strongly acknowledge its benefits, accessibility and proficiency.

5. E-LEARNING FACILITIES AND STUDENT FEED-BACK

Within this section, we synthetically present the results of a student oriented survey administered within some IT courses for BA and MA levels within UBBonline portal – https://portal.ubbcluj.ro for evaluating student’s perception on the course resources that are available by means of the portal facilities. The questionnaire was created and interpreted using the survey functionality built-un in the platform (Share Point Portal) (Andreica Inted, 2012), (Andreica Eduleanrn, 2012). The survey was filled in fairly early portal implementation stages, when the analyzed discipline had already full educational content posted on the portal but few others disciplines had, the learning content being still under development for many other disciplines.

We conclude that the learning facilities provided in the portal for the analyzed courses have a very good feed-back, all evaluated facilities displaying a weighted grade around 4, on a scale 1-5. Nevertheless, these facilities should be used for all courses, by filling in specific content in order to address the students’ educational needs, the process of content updating and auditing being an important part of the learning process using electronic means. Proficient software tools prove their efficiency only when appropriately used on specific data; efficient portal functionalities must be sustained by an adequate usage level and content filling-in in order to prove their proficiency.
6. CONCLUSION

The paper proposes an IT management perspective on information system analysis, providing guidelines for designing proficient IT strategies adapted to organizational goals, and analyzing information systems from the organizational compliance point of view. We consider that these tools are very important in IT management, for designing proficient IT solutions, flexible and valid on a long term perspective.

The case study is performed on Babes-Bolyai University implementations: AcademicInfo system for academic management, Research Management system and ManageAsist system for administrative management, as well as on the global e-learning portal UBBonline that has been developed in order provide integrated e-learning facilities, to integrated the dedicated information systems and to synchronize their databases. From the users' perspective, we present the results of a questionnaire dedicated to student feedback regarding portal facilities. Students express a very positive perception on the portal e-learning functionalities and sustain its wide usage, in order to provide on-line educational resources for all courses. We conclude that efficient portal functionalities must be sustained by an adequate usage level and content filling-in in order to prove their proficiency.

ACKNOWLEDGEMENT

We thank the whole development team in our IT department for their contribution to developing ManageAsist, AcademicInfo, Research management information systems and UBBOnline portal: F. Covaci, D. Stuparu, G. Pop, F. Tufiş, C. Miu, S. Nemeş, D. Pop, M. Bojan, C. Pavel, A. Iuhos, Kerekes H., Zőlde A., A. Bara, Kerekes T. We thank the Brinel implementation team for their work in implementing UBBOnline portal: C. Câmpeanu, R. Gadi, C. Tarţa, G. Mârcuș, F. Chira, O. Teodorescu.

REFERENCES

Andreica, Alina Bianca, 2009, IT Management, EFES, Cluj-Napoca
Kendall, Kenneth E., Kendall, Julie E., 2008, Systems analysis & design, Pearson/Prentice Hall
ABSTRACT

With the growth of the software industry in recent years, plan and manage well the development become vital practices for coordinating effectively a software project. Within this context the estimation process presents as basis for achieving a good planning and control of software projects. However, there are few sources that show a guideline of how to perform it. So, in order to fill this gap, this paper proposes a model to manage the software estimation process through maturity levels and services, thus establishing a way to implement it gradually and that fit the reality of each organization.

KEYWORDS

Maturity Levels, Service, Estimate Process, Management Estimates

1. INTRODUCTION

One of the big challenges of software engineering is accurately estimate the effort, cost and schedule required to develop a software (Moløkken and Jørgensen, 2003). Accurate estimates are important in many areas of development: they are the main input for planning and project control, for all decisions concerning the budget, for bidding, among others (MacConnell, 2006).

According to the Chaos Report (Eveleens and Verhoef, 2010) estimates unrealistic is the most frequent cause of failure in software projects. The root of the problem is that many projects don’t meet the estimated deadlines and break the budget. Several studies during the years has been done to try remedy this problem. Therewith many methodologies and techniques have been developed, refined and combined for this purpose (Jørgensen and Shepperd, 2007).

Still, doesn't come to a unanimous model, because each of the techniques and methodologies to meet a certain kind of problem or are based on empirical research (Jørgensen and Shepperd, 2007). So, many organizations get lost in how implement, manage and use these techniques and models. This fact often ends up causing failures in planning and controlling of software development, resulting in financial losses.

One practice that can help these organizations execute their estimates in a way organized, more reliable and accurate is the use of a standardized process (Peixoto et al., 2010). It gives a basis for using the steps required to estimate, to manage the process execution through points of assessment, validation, and so on, unlike the use of a technique alone.

Thus, this work aims to help these organizations to apply and manage effectively these techniques via a process. To accomplish this task, we propose a model based on maturity levels and services that will help the deployment and management of the estimating process. It is noteworthy that there aren't references that combine the use of a model with maturity levels and the software estimation process.

This work is divided as follows: section 2 and 3 bring a brief theoretical review of the estimation process and models based on maturity levels, respectively. In section 4, the proposed model is presented, section 5 contains a case study of the application of the model and finally section 6 contains the conclusions and future work.
2. ESTIMATION PROCESS

Estimating software development is a continuous process and should be performed throughout the project life cycle (Agarwal et al., 2001) (Peixoto et al., 2010). This process usually consists of some phases as: estimate size, effort, cost, schedule, resources, assess risks, verify and validate the estimates, track and re-estimate, measure and improve the process. The common organization of these steps can be seen in Figure 1.

In an estimation process inputs such as project scope, priorities, constraints are considered. Data from past projects are also used as input to make estimates and calibrate models (Mittas and Angelis, 2010). The step of re-estimate is primordial to update the estimates when new project artifacts are available or that any restriction is added, changed or deleted from the project.

3. MATURITY MODELS

Maturity models seek to establish levels of evolution processes, called maturity levels that characterize stages of improvement in implementing process within the organization (SOFTEX, 2011). These maturity levels, in turn, indicate the company profile and the ways to improve the process in question. Among the various existing models can be highlighted:

**Capability Maturity Model Integration (CMMI):** is a maturity assessment model created and maintained by the Software Engineering Institute (SEI), whose focus is on the processes of Information Technology (IT). This model has five maturity levels: Initial, Managed, Defined, Quantitatively Managed and Optimizing (SEI, 2010).

**Reference Model for Software Process Improvement (MR-MPS):** the development of this model is coordinated by the Association for Promotion of Brazilian Software Excellence (SOFTEX, 2011) in conjunction with several national companies. Contains seven levels of maturity: In Optimization, Quantitatively Managed, Defined, Largely defined, Partly Defined, Managed and Partly Managed.

**MIS-PyME:** it's a maturity model to implement metrics programs oriented small and medium enterprises (Diaz-Ley et al., 2010). The model contains six levels of maturity: Incomplete, Executed process, Managed process, Established process, Predictable process and Process optimization.

**GAIA Risk:** model developed to manage risks during the project life cycle. It is based on services that are the components that must be met at each level (Gaffo and Barros, 2012). The Gaia Risk consists of five maturity levels: Initial, Known, Standardized, Managed and Optimized.

4. PROPOSED MODEL TO MANAGE THE ESTIMATING PROCESS

The model is composed of six maturity levels and a questionnaire. Its purpose is assist the implementation and evaluation of the software estimation process like illustrated in Figure 1. The levels are formed by services that aim to help the execution of each step of the process. The obtaining of services occurred, in turn, by fragmentation of the process of Figure 1 and the ten steps listed by Galorath and Evans (2006) for the execution of the estimation process.
The organization of services within the maturity levels and the establishment of them follow the standard CMMI (SEI, 2010) and the process of Figure 1. This organization follows the assumption that a company that implements CMMI already has available the necessary resources to assist the implementation of a given service.

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Heuristic Approach to Estimate</td>
<td>Formal Sizing</td>
<td>Parametric Models</td>
<td>Risk Assess</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Derivation of Simple Models</td>
<td>Measurement and Analysis</td>
<td>Comparison process</td>
<td>Verification and Validation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Maturity Levels and their Services

Figure 2 shows the model with its levels and services. The choice of using services as components of maturity levels follows the proposal used by Gaffo and Barros (2012). Below follows a description of the 6 levels of the model and as each service is composed.

**Level – 0 (Not performed):** Level 0 comprises organizations that don’t perform estimates on their projects.

**Level – 1 (Known):** This level provides two services: Historical Database and Heuristic Approach to Estimate, aiming to help organizations that are starting to estimate. Here the process is already known, but doesn’t run with all its components.

**Level – 2 (Performed):** At level 2 process is already known and implemented, with most of its steps, within the organization. This level is the organization has greater knowledge of their own software development process (SDP), so there is a greater familiarity and ease to implement services that are other area dependent. The services of this level are: Technical Base and Purpose, Formal Sizing, Derivation of Simple Models, Derivation of Simple Models, Process of Data Collect and Measurement and Analysis.

**Level – 3 (Defined):** At this level the process is executed completely and is standardized within the organization. The organization already has every base to implement all steps of the process and to manage it. The services of this level are: Formal and Repeatable Process, Parametric Models, Comparison process, Risk Assess and Verification and Validation.

**Level – 4 (Controlled):** At level four the process is already well known within the organization, its boundaries are clear and there is a good basis of data collected from past projects. So is possible control the process execution statistically, knowing the areas of higher productivity, error rates, variance and so on. What may also help to better understand the development environment as a whole. The services of this level are: Statistical Analysis of Estimates and Lessons Learned.

**Level – 5 (Improvement):** At this level the process is reviewed periodically aiming identifying possible areas for improvement as well as bottlenecks in implementation. The service of this level are: Process Review.

Each service is composed of five areas, which keeps information organized and can be customized according to the need of the project, client and organization. Figure 3 shows the basic structure of the service verification and validation.

![Figure 3. Service of Verification and Validation](image)

The information that comprise each service were based on the framework proposed by Gaffo and Barros (2012).
4.1 Assessment Questionnaire

The assessment questionnaire aims to evaluate the implementation of estimating process, from the levels and services defined in the maturity model. It determines the rank values to the services model, the criteria for determining the level of maturity of the organization and provides an evaluation process. This part is based on ISO / IEC 15504 - Part 2: Process Assessment (ISO / IEC, 2003).

The level of process maturity estimate will be reached this level when services are fully or largely achieved. The questionnaire contains a set of questions for each attribute specified in the maturity model. The answer to each question can be simply "yes" or "no".

If 0-15% of the answers are "yes", the service was not achieved, 15-50% of the answers are "yes", the service is partially achieved 50-85% of the answers are "yes", the service is largely achieved, and 85-100% of the answers are "yes", then the service is fully achieved. If a question cannot be answered, since it is not applicable to the context, this issue is not taken into account. These thresholds are proposed in ISO / IEC 15504 and all questions are of equal importance.

5. STUDY CASE

As a study case was applied the assessment questionnaire in two software development companies, one from academic sector and another private sector. The company A (academic sector), develops software for Web, has about 15 members they are students of the undergraduate and graduate course in computer science. Company B is a privately company that develops software aimed at the public sector, they have a staff of 31 employees.

In this study case we applied the questionnaire for, that first moment, assess the maturity of companies regarding their practices of estimates. The questionnaire contains a total of 57 questions are divided as follows: 6 questions for level 1, 15 for level 2, 25 for level 3, 7 to Level 4 and 4 to level 5. A level is considered completed if the services that compose at least are largely achieved and the services of the lower levels are fully achieved. Not recommended the deployment of services that belong to two levels ahead of the current level, because there may be no technical basis for its implementation effectively.

5.1 Results

The result of the application questionnaire is summarized in table 1.

<table>
<thead>
<tr>
<th>Levels</th>
<th>Services</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Level 1</td>
<td>Historical Database</td>
<td>Fully achieved</td>
</tr>
<tr>
<td></td>
<td>Heuristic Approach to Estimate</td>
<td>Fully achieved</td>
</tr>
<tr>
<td>Level 2</td>
<td>Technical Basis and Purpose</td>
<td>Fully achieved</td>
</tr>
<tr>
<td></td>
<td>Process of Data Collect</td>
<td>Largely</td>
</tr>
<tr>
<td></td>
<td>Formal Sizing</td>
<td>Fully achieved</td>
</tr>
<tr>
<td></td>
<td>Derivation of Simple Models</td>
<td>Fully achieved</td>
</tr>
<tr>
<td></td>
<td>Measurement and Analysis</td>
<td>Largely</td>
</tr>
<tr>
<td>Level 3</td>
<td>Formal and Repeatable Process</td>
<td>Partially</td>
</tr>
<tr>
<td></td>
<td>Parametric Models</td>
<td>Not achieved</td>
</tr>
<tr>
<td></td>
<td>Comparison Process</td>
<td>Not achieved</td>
</tr>
<tr>
<td></td>
<td>Assess Risk</td>
<td>Partially</td>
</tr>
<tr>
<td></td>
<td>Verification and Validation</td>
<td>Not achieved</td>
</tr>
<tr>
<td>Level 4</td>
<td>Statistical Analysis of Estimates</td>
<td>Not achieved</td>
</tr>
<tr>
<td></td>
<td>Lessons Learned</td>
<td>Partially</td>
</tr>
<tr>
<td>Level 5</td>
<td>Process Review</td>
<td>Not achieved</td>
</tr>
</tbody>
</table>

Analyzing the results contained in Table 1, it can be concluded that the company A is at level 2, because all services at level 1 are fully implements, and implements all services for level 2 largely or fully. At level 3
partially implements two services and doesn't implement other three, so didn't achieve the requirements of this level. Company B is at level 1 of the model, because despite implement all services Level 1 the Level 2 services aren't at least largely implemented.

Was observed with the outcome of the application of assessment questionnaire in company B, that its partially implements the service of parametric models. But as shown in Table 2 service Process Data collection is not largely implemented. This could harm the service tasks of parametric models, because there is no basis for this calibration and this factor is essential for the efficacy of techniques like that (Mittas and Angelis, 2010). Therefore, it was considered that Company B is not mature enough to implement this service, which can generate too much effort to run it, inconsistent and inaccurate results.

6. CONCLUSION AND FUTURE WORK

As explained in this paper, the process of estimating software is a great help to organize and apply techniques to get accurately estimates in software projects, thereby contributing to its success. But there are few ways that guide how to apply this process. Thus, was considered that the proposed model achieved his goal to filling this gap, establishing a clear, effective and gradual way to implementation via maturity levels and services.

By the study case, we conclude that the model can evaluate good practices estimates within an organization and position it within the levels of the proposed maturity model. Besides be able to identify practices that shouldn't be implemented, because there isn't enough maturity of the organization to perform this task.

The study was limited in the first instance to position the organizations within the model and verify if their estimation practices are consistent with their reality. As future work we intend besides positioning organizations within the model also deploy the services within them and observe their behavior. The data about the services deploy behavior also will serve as feedback for improving the model.

REFERENCES

SEI, 2010. Capability Maturity Model Integration (CMMI-DEV v1.3): Improving processes for developing better products and services. Software Engineering Institute, Massachusetts, USA.
WORKFLOW INTEGRATION INTO INFORMATION SYSTEMS FOR BUSINESS PROCESSES OF EUROPEAN COLLABORATIVE PROJECTS

Klaus Bittner, Daniel Kimmig, Iris Warlo and Steffen Scholz
Institute for Applied Computer Science, Karlsruhe Institute of Technology - Karlsruhe, Germany

ABSTRACT
This paper presents an approach to efficiently support business processes by the use of an information system (IS) integrated workflow interaction method for distributed environments. Experiencing time consuming business processes in European funded projects with up to thirty participating organisations distributed all over Europe, the objective of our research work is to implement and develop a suitable workflow management system to automate and centrally store as well as archive all means of collaboration, which stem from, e.g. the execution of standard operating procedures necessary to the project. The main objective was to develop a method for users to handle and record each process step in a convenient, appropriate and standardised way.

The approach in this paper is based on a reusable workflow method with dynamic PDF forms, which are distributed from a server via email. The user completes highlighted sections in the PDF form and sends a reply, which triggers the workflow engine to start respective actions. This workflow method has been implemented in two European collaborative projects and the results provide evidence that the performance of business processes has been increased significantly.

KEYWORDS
Workflow, Business Processes, European Projects, MS SharePoint, PDF Submission, Collaboration

1. INTRODUCTION

The integration of business processes into an appropriate workflow management system has proven to be a challenge even for large scale companies; even more so, in the context of European collaborative projects with heterogeneous IT environments. With the reinforced globalisation and the impulse to build up international cooperations with partner organisations, there is also a need to use a workflow management system not only for the intranet area, but also for the interaction with partners (e.g. supplier or customer). A similar situation exists in European funded projects. The project consortium can include up to thirty project partners, coming from industry, academia and research. This implies that partners are spread around Europe and usually have their own infrastructure consisting of heterogeneous and proprietary information and workflow management systems with highly individual authorization models. As European projects run only for a limited period of time, it is unfeasible to create secure and robust interfaces between the systems of all participating project partners. However, to allow a high flexibility in the context of integration methods for workflow management solutions, a central and secure system is required, whose IT environment is commonly independent from the local partner systems.

A special kind of European projects, funded under the FP7 infrastructure scheme allows besides the research component in the project the open user access to partner installations. Users can apply for open access to the installations in order to conduct a feasibility study or a research project for a limited period of time. Starting with a scientific idea, the applicant applies for open access by submitting a proposal. After independent external peer review, the user gets access to a combination of installations from several partners to run the experiments. Furthermore technology experts are responsible for assessing the feasibility of the proposal idea on their installations and also provide information about the amount of time which is required to perform the work. These steps from application to realisation of a user project were outlined in business processes to ensure a structured project overview and to define the various roles and process steps.
The interaction time and the information flow often are limited through IT barriers. Typically workflow management systems have a web based user interface where users first have to log in to update the status of a process step or to upload data. In order to avoid additional login screens corporate intranet solutions have adopted technologies such as Single-Sign-On to enable automatic login across several IT systems. Especially in European collaborative projects, the project partner organisations cannot use these intranet methods as it is not viable to integrate all the different authorization methods underneath a central Single-Sign-On solution. As a result each user would have to authorise before sharing project information. To avoid such a condition and to support the collaborative business processes without additional authorisation an appropriate information system with workflow management technologies for distributed environments has been implemented.

2. RELATED WORK

Workflows can be classified regarding their structuring level. Several authors (Hollingsworth, 1995, pp.37 ff.; Gadatsch, 2010, pp.40 ff.; Wicklund, 2011, pp.14 ff.) differentiate between different types like general, use case and ad hoc workflows. General workflows have a repetitive character and can be predefine in detail. As they are very well structured the user has no decision authority regarding the arrangement of the process steps. In contrast, the process sequence of ad hoc workflows cannot be predefined but the user has to decide which step follows. Use case workflows are the in-between solution, more flexible and not completely predefined (Gadatsch, 2010, pp.49 ff.). Regarding the flexibility and agility of business processes the authors Gong and Janssen (2012, p.61) have developed principles to implement policies more quickly and cost effectively.

There are different technologies for workflow management systems discussed in literature. According to the authors Fakas and Karaskostas (1999, p.908) those evolved across the three dimensions object-orientation, intelligent agents and Internet/Intranets. Nowadays the use of web-based workflow software is widely common like in the system presented in this paper. To store data, the workflow management system of this research uses a relational database. New approaches in this field are using, e.g., document orientated databases. This type of database can encode data for instance in XML files but also in binary forms like PDF or MS Word documents. It belongs to the main categories of the NoSQL databases which besides document stores also uses key-value stores, BigTable implementation and graph databases (Lee et. al., 2012, p.2).

Because of the limitations of extracted XML from XForms and InfoPath (Abler, 2011, p.17) this approach considers more flexible PDF forms. Furthermore, these forms have the possibility to enable write protection to different areas of the document. Consequently, software developers utilised this potential by introducing PDFs into their workflow systems. These are now characterised by the transfer of PDF data from one processing step to the next without significant operator involvement (Zipper, 2001, p.3).

The usage of standard workflow functionalities of SharePoint 2010 with the requirements of European collaborative projects are already described and evaluated (Intlekofer, 2011, p.58). Further workflow management integration into SharePoint 2010 is possible (Wicklund, 2011, pp.65 ff.) especially through the deployment of additional software modules like the SharePoint add-on solutions Nintex Workflow 2010 or K2 blackpoint (Moritz, 2011, pp.16 f.).

3. WORKFLOW INTEGRATION IN INFORMATION SYSTEMS OF EUROPEAN COLLABORATIVE PROJECTS

3.1 Framework of the Information System and Workflow Engine

To integrate a solution which is independent from the heterogeneous software environments of the partners we decided to use the common collaboration tool Microsoft SharePoint 2010, as it is a widely used enterprise standard software within the field of groupware and document management systems. It also offers a limited workflow component. This component is at the current state useful for basic workflows, but if more complex workflow functionalities are required, it is necessary to buy additional software or develop in-house solutions
In this case we decided to develop an alternative integrated method for workflow interaction between each partner. This approach considers the extended requirements of distributed projects and integrates a suitable interaction method for the partner organisations.

The framework of the information management system is based on Microsoft SharePoint 2010 as its core element, connected with an IIS Server for web access, a SQL Server database to store all data and an Active Directory as Identity Service. To avoid additional interfaces the workflow engine for user projects was integrated in the SharePoint environment and developed with ASP.NET and C#. The workflow engine is triggered by incoming XML files in emails from the users and partners. Therefore the engine is connected to an email account from a Microsoft Exchange Server.

The so called ‘use case workflows’ are chosen, because the workflow user needs the possibility to decide which step follows in this case. For example, one partner is asked in a PDF form if he accepts the role as Technical Expert. According to his decision for or against it his submitted content as generated XML triggers different follow-up processes. Either the next step in the business process flowchart can follow or in case of rejection the form is returned to the User Office which then has to search for another expert.

Behind the workflow engine there is a monitoring interface and repository with all necessary PDF form templates, stored in the SharePoint system (see Figure 1).

The workflow was established as a form based workflow and the reasons are several. It represents a standard operating procedure and thus brings consistency and transparency to the process of handling user requests. Moreover, the workflow engine saves all important project data into a SharePoint project list automatically. This meets the requirements in reporting and documentation which European projects are subject to. In addition, it assists the User Office in coordinating various projects at the same time. Another advantage is the possibility to avoid different security barriers in the distributed environments since PDF forms can be submitted without having to log on to any specific information system. Besides, the system includes a timer which in case progression of the workflow stops sends out reminders to the person in charge of the next workflow step. This is one part of an automated early warning system that continuously controls and automatically informs the management office, the research infrastructure manager and the project coordinator of the status of any internal and external processes.

In order to simplify workflows for the user, it was decided to use an email based system for interaction with the different involved people. The business processes (Intake, Evaluation, Realisation, Escalation) are handled through checklists in the form of PDF documents which are based on a list of control questions set up for each process and additional forms like the application form. Thus, once it is their turn to complete a process the different participating parties (Peer Review Board, Technical Expert, User, User Office) receive an automatically generated email from the workflow management system enclosing a specific PDF document.
(see Figure 2). As already described the recipient then can fill out the PDF file and resubmit the XML extract with the content of the PDF fields.

The extracted XML is the basis for the execution of the workflow monitor. The XML is checked and validated in the input pipeline and depending on the configuration of the workflow system the workflow engine starts different actions. With an identifying project number in the XML, the engine can allocate the data to the correct user project workspace (each user project has its own workspace identified by a number).

The initial way to submit the XML-Extract with the content of the PDF form to the workflow engine was via email submission. The user sent the XML file in an email with his Email Client software. This approach also considered an alternative way of submission. In this improved alternative way the user sends the XML file to a webserver which then transmits the XML file as email to the workflow engine.

3.2 Use Cases in European Collaborative Projects

When this information management system was installed for the EUMINAfab project (www.euminafab.eu) – a European Research Infrastructure offering open access to state of the art of multi material micro- and nanotechnologies (Dickerhof, M. and Anson, S., 2011, p.1) – workflows were originally handled via PDF forms which could be submitted to the workflow management system via integrated Email-Client Software. The user would receive an email enclosing forms to complete and to submit by clicking a submit button. In the initial way this opened an email window with all necessary data attached and the email address of the workflow engine as recipient included. In case one user wanted to add any additional information he would have to add them in the body or as an attachment to the email. If the user sent the XML file as email with further attachments, the workflow engine stored these documents in the project workspace so that all project partners could view them on the SharePoint system.

This way of handling included unnecessary steps like the additional email entry mask which slowed down the processing of user projects. Besides, partners without an integrated mail client had a great disadvantage as they first had to save the email to then be able to send it manually. After the processing through the workflow engine which includes the transmission of all information to the next recipient (respectively role) another challenge occurred: The role had to view all given information from the predecessor in three different areas: Information regarding the requested fields of attached PDF form, information in the email body and additional information in the further attached documents.
For the next European Infrastructure project H₂FC – a project to support science and development of Hydrogen- and Fuel Cell Technologies by providing researchers with expert know-how and state-of-the-art installations (www.h2fc.eu) – it was, hence, decided to relieve the project partners from having to send the PDF form via email by connecting the PDF forms to a webserver. With this alternative approach the XML extract of the PDF form consequently no longer has to be attached to an email in order to be sent but can now easily be submitted via the web submit button within the PDF document. Furthermore this reduces the risk of losing information significantly since the data transmission is now operated by the system itself and does not have to be carried out via email communication of the system users. After activating the web submission, the XML data is generated out of the PDF form and is sent to the webserver, which then attaches the XML content to a generated email and sends it to the Workflow Engine Input Pipeline.

To further emphasize the advantages of the submission of the dynamic PDF forms via a webserver the two submission methods via email client software and via webserver are compared in the following Table 1.

Table 1. Comparison of submission methods

<table>
<thead>
<tr>
<th>Initial approach with email client software</th>
<th>Alternative approach via webserver</th>
</tr>
</thead>
<tbody>
<tr>
<td>An integrated mail client is necessary for submitting the completed documents via email. (If not available the automatically generated email has to be saved and attached manually to an online email tool)</td>
<td>No integrated mail client necessary. By clicking the submit button transmission of the document is carried out via the webserver without any further involvement of the editor.</td>
</tr>
<tr>
<td>PDF forms can be submitted without a login on the SharePoint, only security barriers from the email client software slowing down the process.</td>
<td>PDF forms can be submitted without a login on the SharePoint, only security barriers from the operating system could slow down the process.</td>
</tr>
<tr>
<td>Risk of losing data (e.g. XML data could be lost if there are problems with email client software)</td>
<td>Lower risk of losing data because the webserver directly receives the XML file.</td>
</tr>
<tr>
<td>Collection of the different kinds of information from submitted form, email body and attachments is a time consuming process for the project supervisor.</td>
<td>Because it is only possible to include content into predefined fields all given information is already structured (XML) and transmitted to the SharePoint project list after submission.</td>
</tr>
</tbody>
</table>

The general acceptance of this approach could be evaluated by different statistical analysis. After finishing the realisation of each user project idea, the users got a Questionnaire (also as PDF with XML-Submission) to rate several areas. With feedback from 47 users the rating was in average always over 75 % positive regarding the IS solution and workflow areas (see Figure 3). The high acceptance and the positive effect of the integration of the alternative submission approach via webserver could be illustrated by the statistic regarding the average processing time of the workflow steps with the different submission methods (see Figure 4). The statistic shows the average time from submission of the application form till go-ahead acceptance of the project respectively till overall project finished. In both time periods the average time could be accelerated, observable by a considerable reduction (about 55 % till go-ahead respectively 45 % till project finished).

**Figure 3. User ratings regarding IS solution and workflow**

**Figure 4. Average processing time of workflow steps with different submission methods**
4. CONCLUSION AND FURTHER WORK

The new interaction approach to integrate suitable and flexible workflow functionalities for European collaborative projects into IS has improved the usability and the acceptance by the users significantly. This could be illustrated by the acceleration of the average response time from users and high user acceptance rates in questionnaires. The method to send out emails with attached PDF forms to the user to execute the several process steps shows different advantages like the possibility to fill out the PDF form directly without any need for login to an IS.

As a matter of fact the use of mobile devices in daily business has become more and more common. Unfortunately, the operation systems of these devices (e.g. Android or Apple OS) are limited in the functionalities regarding the used dynamic PDF forms. Therefore the PDF based submission system via webservice does not work on most of these devices, which presents an issue especially for those partners who are regularly away on business trips. Thus, this system should be made adaptable for partners using mobile devices to process forms in the near future.

The workflow approach was evaluated in two different European Projects. Most parts of the implementation are generic, so this workflow approach could be useful also for other European Infrastructure Projects or collaborative project groups in completely different areas.

ACKNOWLEDGEMENTS

The research reported in this paper is funded by the FP7 programmes “Integrating European research infrastructures for the micro-nano fabrication of functional structures and devices out of a knowledge-based multimaterials’ repertoire” (EUMINAfab, Grant Agreement Number FP7-226460) and “Integrating European Infrastructure to support science and development of Hydrogen- and Fuel Cell Technologies towards European Strategy for Sustainable” (H2FC, Grant Agreement Number FP7-284522). The author greatly acknowledges the contribution of Markus Dickerhof, Susan Anson, Thomas Schaller and Olaf Jedicke.

REFERENCES


Intlekofer, K., 2011. Evaluierung der Workflowfunktionalität von MS Sharepoint 2010 am Beispiel der Geschäftsprozesse eines EU-Forschungsprojektes, B.Sc., Hochschule Karlsruhe


ABSTRACT
Information Technologies (IT) have helped businesses to look for new ways of competing. Social Media (SM) are considered as one of these technologies. There are ample examples in the literature about its effectiveness in business. Especially for small businesses (SMEs) SM have given an opportunity to create a global customer base in a cost effective manner which was not possible in other business model. The main aim of this research was to investigate how SMEs whose businesses are dependent on their networks can benefit from SM. Although there are many IT adoption models, only a very few focus on SM alone. According to our knowledge there is none which focuses on SM adoption by SMEs. This research aimed to come up with a suitable model which will help SMEs to evaluate their readiness in adopting SM.

KEYWORDS
Social Media readiness, Social Media adoption, Small Businesses, competitive advantage.

1. INTRODUCTION AND BACKGROUND

In the information society we live today, time and speed has become critical factors to customers. Customers are more aware of market trends, substitute products and services available and demand for quality at affordable prices. Technology has become paramount in achieving these objectives. Organisations are increasingly realising the power of Social media (SM) as a new way of reaching customers, and creating differentiation, and even for launching new businesses.

Most companies have realised that an increasing number of customers are spending a significant amount of time on SM platforms today (Mortleman 2011). According to the Facebook (2012), it had over 901 million active users by March 2012. Such statistics show the increase usage and the power of the medium that could be harnessed by organisations. However, there are some businesses which are still wary of using SM, citing reasons such as security and privacy. Most of the existing literature tends to write about the value of SM (Ferrand 2009) and little attention has been given to the need for organisation to be prepared before adopting SM especially for SMEs. This research aims to fill that gap.

1.1 What is Social Media?

There are a variety of definitions for SM in the literature. Some have defined SM from a technological perspective, while other definitions are based on SM types and functions. Some definitions combine both perspectives.

We consider social media from the technological point of view while highly acknowledging other definitions and arguments. In this research we refer to Social Media as any communication and interaction taking place in real time by using internet-based technologies. Our focus is on the communications that occur between organisations, customers and suppliers.

1.2 Guides that Influence the Successful Adoption of Social Media

The literature is rich with guidelines to follow in order to adopt SM in SMEs. Authors such as Gilaninia et al. (2001) posits that these guides help SMEs to have critical observations about what to do before taking any further steps to ensure the desired advantage. We discuss some of the important guides that are highlight in the literature below:
1. Setting the goal for social media adoption: SM strategy should add value to SMEs. Authors such as Ormond (2012) and Prohaska (2011) argue that SMEs must first determine their SM adoption goals and decide whether these goals are for marketing or managing customer relationships. Johnston (2011) shares a similar point of view and argues that without a specific goal it is hard to know if the SM adoption has succeeded or not.

2. Applying culture of openness and transparency: Thomson (2009) says that if the business has got the right type of culture, technologies will work a lot better for them. Cuccureddu (2012) states that having a culture of openness and transparency is a key factor for a successful social media strategy.

3. Targeting customers: Thomson (2009) states that the company decision should depend on their goals and target customers. Lake (2012) mentions that company message could be stronger and relevant if it narrows its niche market.

4. Identifying social media policies: Mortleman (2011) raises concerns over the fact that most SMEs do not have a formal policy to manage SM adoption. Ball (2011) confirms this stating that even in SMEs with employees more than 25, almost 50% are without formalised SM policies. McCarthy and Krishna (2011) point out that without such a policy employees turn out to be unsupervised spokespeople.

5. Creating compatibility between social media strategy and the existing business functions: Gilaninia et al. (2011) state that SM strategy must fit with the existing business processes of the organisation. Springman (2012) argues that it is easier to develop an isolated SM strategy but it will be less effective than a strategy which is integrated with other business functions.

1.3 Existing Frameworks for Social Media Adoption

There are a number of frameworks on how to adopt SM in businesses. To our knowledge all these frameworks are for large organisations. We find that little effort has been made to develop a framework for helping SMEs to evaluate their readiness to adopt SM. Such a framework will help SMEs to have a clear understanding about how SM should be used or whether they should be used at all, and help them to gain competitive advantage from them.

Among the many research studying IT adoption within an organisation, Tornatzky & Fleischers’ (1990) Technology-Organization-Environment (TOE) framework is one of the well-accepted models. TOE framework has been adopted and validated by many firms with diverse technology innovations and various contexts (Omosigho & Abeysinghe 2012). Oliveira & Martins (2011) consider the contribution by the TOE framework as significant.

Based on the TOE framework Omosigho & Abeysinghe (2012) have proposed a framework for assessing the readiness of organisations prior to adopting SM. The framework has been validated for the use of large organisations. Their framework is influenced by three main factors: technology, organization and environment. Similar factors are discussed by Burgess et al. (2009) about SMEs web presence readiness. We aim to customise the framework of Omosigho & Abeysinghe (2012) for SMEs.

2. THE PROPOSED FRAMEWORK

The conducted literature survey was focused on finding guides that influence the adoption of SM by SMEs. The findings were prioritised based on their importance into five guides as discussed in Section 1.2. Based on these guides hypotheses were formed. The credibility of the hypotheses was tested by conducting a survey among SMEs. From the survey results the main factors in the framework were finalised.

2.1 Framework Concepts

The proposed framework (Before, Process and After (BPA)) presented in Figure 1, consists of three main stages: Before adopting SM; Process of adopting SM; and After adopting SM. Each of these stages is influenced by technological, organisational and environmental factors but with a focus on SM. By dividing the framework into three stages (where each stage includes multiple steps) the SMEs will have the opportunity to follow the framework at any stage. It also enables the companies which have already used SM to understand the factors that influence the adoption of SM. Johnston (2011) and Prohaska (2011) believe
that a clearly defined framework which contains steps will guide companies to create a successful SM outreach. Moreover, it gives them a sense of achievement and enables them to measure their success in each stage.

Figure 1. BPA framework

The BPA framework consider three aspects that influence the process of adopting SM in SMEs:

1. **Technological context**: Describes the external and internal technologies that are related to the company. Since SM are enabled by technology, technological aspect is considered in all the three stages.

2. **Organisational context**: Factors considered here are the same as those discussed in Section 1.2.

3. **Environmental context**: Environmental context as defined by Tornatzky & Fleischer (1990) is adopted here. Companies are influenced by external factors such as their industry and competitors. Large organisations differ to SMEs in that they have access to variety of resources and able to react to technological pressure. However, some SMEs struggle to adopt new technologies due to the lack of knowledge and skills (Rashid & Al-Qirim 2001).

### 2.2 The 3 Stages of the BPA Framework

The first and the third stage of the framework explain the organisational context by utilising a number of factors. The middle stage highlights the importance of environmental factors on SM adoption as well as organisational factors. Since the technological context lays the foundation for understanding the technology use within the business, the technological context is included in all the three stages.

#### 2.2.1 Before Adopting Social Media

**Setting Goals** is an essential step for companies that want to adopt SM because no strategy makes sense without clear goals. Ormond (2012) believes that the success starts from clear cut goals and understanding the desired outcome for the business. **Hypothesis 1(H1):** SMEs need to have clear and specific goals before adopting SM.

**Defining SM Purpose** is very important. A business goal is to increase the monetary gain; the main concern is how they want to increase it: by targeting new customers, maintaining the existing ones or by advertising. Mangold & Faulds (2009) argue that without a clear purpose companies will struggle to reach their goals. **Hypothesis 2(H2):** SMEs need to define the purposes they want to achieve with the help of SM.

According to Thomson (2011) technologies will be more affective in any business with the correct type of **Organisational Culture**. Holtz et al. (2008) believe that if companies want SM to have a successful influence in their business, it is essentials for them to be social first. Owyang et al. (2011) identify fostering a culture of learning as one of the essential business requirements for SM success. **Hypothesis 3(H3):** SMEs need to have a culture of openness and transparency before adopting SM.
2.2.2 Process of Adopting Social Media

Companies need to **Identify SM Policies** to get the benefit from their adoption. Owyang et al. (2011) reveal that organisations which are most advanced in SM have “established and reinforced a SM policy that allows the employees to participate professionally”. **Hypothesis 4(H4):** SMEs need to develop policies to gain competitive advantages from SM adoption.

**Compatibility of SM Strategy with the Existing Business Functions** is likely to lead to success as stated in Springman (2012). Johnston (2011) supports this by stating that SM strategy must be synchronised and not independent from the company's divisions such as customer services and human resources. **Hypothesis 5(H5):** SMEs need to ensure compatibility of SM strategy with the business.

**Targeting audience** is considered as environmental context because the impact of this factor is external whereas, deciding which SM platform to choose depends on company goals and recourses hence, it is considered as organisational context. This is the only step which has two contexts in the BPA framework. **Hypothesis 6(H6):** SMEs need to focus on choosing the best platforms where the people they want to reach are active; this will decrease the risk of failure.

2.2.3 After Adopting Social Media

To ensure that the company is taking full advantage from SM, they have to **Monitor Engagement** of their customers. Orsini (2010) highlights that companies need to listen with an open mind to what their customers are saying whether their comments are explicit or implicit. Mortleman (2011) takes a similar position by stating that monitoring gives the companies insight about their customers' opinions towards brand and products. **Hypothesis 7(H7):** SMEs need to have a system to monitor SM use.

The **Revise and Update Strategy** stage deals with how SMEs gain insight and improve their SM strategy. Falls (2011) states that even those organisations which can be categorised as ‘advance’ do not have an effective process in place to integrate the customer data into their product roadmap or support systems. SM not only challenges existing information infrastructures but also changes existing routines, processes and procedures. This disruptive nature of SM makes it inevitable that existing strategies need to be modified and/or changed and new strategies introduced. **Hypothesis 8(H8):** Revising and updating SM strategy is necessary to take advantages of SM adoption.

3. CASE STUDY ANALYSIS

To answer the main questions of this research, five SMEs from Saudi Arabia were selected from different sectors: Company A: an online entertainment channels; Company B: a chocolate company; Company C: an online personalised T-shirt store; Company D: a homemade chocolate store, and Company E: a professional photographic studio. A survey was used to collect relevant information regarding how SM impacts these businesses and how they prepared themselves before adopting SM. Based on the data collected BPA framework was applied to each case study and analysed.

**Before Adopting Social Media:** All the 5 companies had specific goals prior to adopting SM. Company A, to improve their brand image, and the other companies to increase their customer base; hence increase their profits. All 5 companies defined their SM purposes prior to adopting SM which are mainly advertising, taking customer orders, and Customer relationship Management. However, although all the companies ran their business from SM, they did not have a culture of openness to begin with. Companies A and E claim their friendly culture, is the nature of their business. But, Companies B, C, and D have a formal culture in their business, which they argued is necessary to discipline the workplace.

**Process of adopting Social Media:** All companies except Company C, developed a SM policy to determine what should/should not be used in SM. Company E also includes SM responsibilities among employees in their policy. Although Company C had a very formal culture it did not identify a SM policy. Most of the companies did not fully integrate their SM strategy with existing strategy. Companies A and B argued that since the company was running via SM integration is a given. The other companies agreed that SM adoption would be more effective if strategies are integrated together. All the 5 companies defined their SM audience and platforms before adopting SM. Company A chose Youtube as its primary SM platform.
since it is a Media Company. The initial goal of Companies B, C and D were to increase customer base so, they selected the most popular platforms in their respective fields which are Facebook and Twitter. All companies understood the importance for SMEs to identify their targets when deciding to adopt SM.

In order to guarantee their success in SM Company A considered that feedback from customers and increasing its fans/followers numbers in SM platforms as measurement for success. The rest of the companies used the number of posts, comments and customers participated as their measurement of success. All the companies, except Company E realise that to ensure the success of their SM adoption and to ensure that they are in the right track; they have to revise and update their SM policies.

Even though this research was carefully prepared, there were some unavoidable limitations. The age of all SMEs used as case studies was less than five years which is after SM have been introduced to the business. Therefore, they have already developed a SM strategy as a part of their overall strategy. Hence, compatibility between business strategies was not applicable to these cases.

4. CONCLUSION

The capability of SME’s in reaping benefits from SM opportunities depends on how ready they are to embrace not only the technology but also the challenges which come with it. In this paper we developed a framework which can assist SMEs in evaluating their readiness to adopt SM. The framework focuses on SMEs that have already adopted SM. This is considered as strength of this paper given that most approaches only focus on prior adoption of technologies.

The results of this paper point to several interesting directions for future work. The framework could also be applied to long standing SMEs, which have developed their SM strategy long after their business strategy. This will ensure the applicability of the framework SMEs in general. The selected case studies were from one particular geographical region. This may have some bias on the validation. The framework needs to be further evaluated to improve its validity and usefulness.

ACKNOWLEDGEMENT

Special thanks go to the small businesses entrepreneurs for making this study possible by providing their valuable contribution by providing us with the data and validating our framework.

REFERENCES


FACTORS OF ENTERPRISE RESOURCE PLANNING (ERP) SYSTEMS IMPLEMENTATION IN A LIBYAN OIL COMPANY

Dr. Almahdi M. S. Ibrahim
Faculty of Economics and Accountancy, Sebha University, Libya

ABSTRACT
The paper is built on the literature review by constructing the theoretical framework that will be used to develop the research instrument. That will assist our efforts to research into the ERP related-factors for an Enterprise Resource Planning (ERP) implementation success, and to have a guidance framework to conduct an investigation and capture research data. The theoretical framework implies the soft ERP related-factors along stages of ERP implementation. It has been developed to aid the research process. The aim of this research is to investigate the “soft” ERP implementation related factors affecting the introduction of ERP in a Libyan oil company. This aim is reflected on the following objectives: To review the literature on ERP related matters, to construct based on the literature, a theoretical framework that reflects soft ERP implementation related factors, to investigate the soft factors influencing the implementation of ERP in the case study company, to explore in and understand the links between soft factors and ERP implementation stages in the case study organisation and to analyse the data obtained from the case study organisation.

KEYWORDS

1. INTRODUCTION
Enterprise Resource Planning (ERP) software is a set of applications that links systems such as manufacturing, financial, human resources, data warehousing, sales force, document management, and after-sales service together, and helps organisations handle jobs such as order processing and production scheduling. The attention of researchers in implementing ERP solutions should shift from the “hard” elements to the “soft” issues related to such an implementation, i.e. address human-related and organisational culture problems, when trying to explain the reasons for ERP implementation failures (O’Kane, 2004). Moreover, an effective ERP implementation requires appropriate managerial interventions as part of the implementation process. In this regard, our study considers soft ERP related requirements in the process of introducing such a system. The theoretical framework that has been developed portrays the “soft” critical success factors in the process of implementing an ERP system. It has been developed through a critical synthesis of the relevant literature. This paper introduces the way the theoretical framework has been constructed. The factors that are incorporated in the framework are described in detail and the relationships between them are evaluated in the light of a potential implementation in a Libyan Oil Company. The framework under concern has formed the basis of an empirical case study investigation that has been conducted in the Libyan environment. The researcher has derived from the literature several soft related factors that contribute to the successful of implementation of an ERP system. Such a process was invaluable in developing a thorough understanding of the process of implementing an ERP system. Nevertheless, and as discussed above, only the first category of factors has been further considered for experimentation purposes. The “soft” category further divided into generic factors and factors that are particularly relevant only in the Libyan environment.
2. FACTORS RELATED TO ERP IMPLEMENTATION

In this section theories and frameworks that consider factors related to ERP implementation are discussed. In particular, two frameworks developed by Huang and Palvia (2001) and Holland and Light (1999) are considered in detail and are used as the basis for further discussion. The work of other researchers is also reviewed in order to develop the researcher understanding of the analysis of critical success factors. From the review of the literature, ERP systems have not been given appropriate research focus based on the CSF’s in developing countries. Thus should be more focus to study CSF’s related to different context, because these factors may change over the course of ERP implementation of the dynamics of project life cycle. Moreover, it has been noted that many researchers have concentrated exclusively on the technical aspects, while slightly focusing or ignoring the managerial related aspects. Recently the attention of researchers, concerning success factors of an ERP implementation, has shifted from the hard factors to the more soft factors, addressing human and cultural factors when trying to explain why ERP implementations fail (O’Kane, 2004). Soft factors in ERP implementation become more significant as the level of change required of the organisation’s business processes is more important. The soft ERP success related factors include top management commitment, communication, organisational culture, project team, education and training, user satisfaction, employee attitudes, users involvement, excellent project management, process management, IT maturity, computer culture, clear goals focus and scope, ERP strategy, legacy systems and empowerment.

3. ERP IMPLEMENTATION STAGES

The implementation of an ERP system in an organisation is a very complex project. The implementation of such systems is difficult and involves a high cost, as well as considerable time and resources. Organisations that need to go into such a project must be aware of the necessary commitments. Many researchers have proposed stage models of ERP implementation (Langenwalter, 2000; Umble et al., 2003; and Gupta et al., 2004). It can therefore be argued that both hard and soft issues should be stressed in implementing ERP projects. As technical knowledge is required, strategic, organisational and people-related factors are significant in the success of an ERP project. Strong top management commitment is a most important issue in successful ERP implementation, as it involves a lot of changes in the organisation. Also effective communications, effective project management, training and implementation team are essential throughout an ERP project in order to bind the various activities together. It can be seen that soft issues are much more demanding in ERP projects compared to many more conventional projects. It is thus argued that the stages of ERP implementation can be characterised as a journey with six stages. Moreover, these stages can be linked to the soft ERP success related factors. The first stage conducts feasibility studies. The second stage in implementing ERP in an organisation is to plan for the system. Selecting the appropriate system is the third stage. In fourth stage of pre-implementation. Many activities related to the technical and people-related aspects should be carried out in the actual implementation stage. The final stage is to the post-implementation process.

4. THE PROPOSED THEORETICAL FRAMEWORK

The theoretical framework to be used for the purposes of this research has been developed based on an extensive review of the literature. It comprises strategic, people related and organisational factors and attempt to relate these to various the stages of the implementation of ERP systems. The framework represents three main sets of factors, namely strategic factors, people related factors and organisational factors. No attempts have been made in the academic literature to link any soft critical success factors to the various ERP implementation related stages. A theoretical implementation is suggested that there is an explicit linkage between factors and ERP implementation stages.
5. RESEARCH METHODOLOGY

The broad aim of this research is to investigate the soft related factors to the process of implementing an ERP system. On the basis of the main aim and objectives, a single case study approach was used for the purpose of answering the specified research questions, whereas semi-structured interviews, documentation review and observation have been chosen for the data collection process. The use of a variety of research methods aimed to achieve the triangulation of data and therefore reduce bias. The research instrument has been developed based on the research objectives, and the pilot study has been addressed to provide clear understanding about the research problems. The interviewees were general managers, middle managers, IT technicians and end users from the different departments within the company under concern. The empirical data confirm the validity of the proposed framework and enable insight to be gained into other issue of particular importance in the process of implementing an ERP system.

6. THE CASE STUDY COMPANY

A company was the first oil company to be completely owned by the Libyan people after the nationalization decisions and is now as one of the biggest oil companies in Libya, and stands proudly as one of the largest oil companies in North Africa. It has been adopted an ERP approach to maintain distinction, following scientific principles and practices in production operations. ERP system has been found in four main functions in this company. The company has broken down ERP packages in modules that handle several functional departments including accounting, finance, human resource and material management and they left the rest of the functions to be installed in future.

7. THE CASE STUDY FINDINGS

This section provides a detailed description in the two case studies of the link between soft ERP implementation related-factors and the stages of ERP implementation. In feasibility studies stage, the respondents in the case study indicated that top managements created suitable environments for adopting ERP. Further, their commitment is continuing into the post-implementation stage. ERP strategy is an important factor, and it should start at the beginning of the project and continue throughout its entire life cycle. The respondents stated that these strategy efforts began during the pre-implementation stage. Many authors have indicated the importance of this factor, such as Al-Mashari et al. (2003), and Umble et al. (2003). However, no one has yet examined the importance of this factor in particular implementation stages. The respondents outlined that training and education regarding the ERP system for all employees should start at the beginning of the project. User involvement and attitudes were identified by respondents as most important factors, and these factors should be focused on in the early stages of ERP implementation processes. Computer culture and IT maturity were stated by the interviewees as important factors in the very early stage of the adoption of ERP systems. There was a lack of mentioning to these factors in the previous literature. Responses from staff in the case study company outlined that communication is more important at the beginning of the stages of implementation where employees should be informed step by step regarding the new development in order to motivate them and reduce resistance to adopting the new technology. However, no attempts have been made in previous studies to link such a factor with the stages of ERP implementation. The motivation and encouragement of employees to adopt the ERP system and the development and renewal of laws and regulations have been found to be unique factors in Libyan oil companies. These factors have not been reported before in the literature, and are unique to this research because of Libyan legislation, politics and culture. In addition, they are also shown to be more important at the early stages of the process of ERP implementation. Experience of working with similar software is also revealed as a unique factor, which also has not been reported before in the literature. This factor has been found to be more significant in the early stages of adoption of the ERP system. In planning stage, effective project management was defined by respondents in the case study as an important factor in the planning stage. This factor has also been defined as a significant factor in studies done by Remers (2002), Al-Mashari (2003), Al-Mashari et al. (2003), and Gargeya and Brady (2005). Organisational culture and structure are
also important factors that influence the success of ERP implementation. The respondents stated that these factors should start before selecting an ERP system. Employees do not want to change the way they do their jobs, whereas the ERP system requires that employees change their ways of working. Thus, it is important in the early stage to develop a culture that enables this kind of change. Furthermore, respondents mentioned that the main business processes should be redesigned and developed in the early stages to support a variety of organisational structures. The importance of these factors have been noted research by Al-Mashari *et al.* (2003), James (2004), and O’Kane (2004). However, no like has been made between these factors with the stages of ERP implementation. In selection stage, according to the respondents in the case study company, the project teams consisted of business and IT technicians from the company and from Oracle developed company. Respondents also indicated that a balanced and empowered project team in the pre-implementation to post-implementation stage will lead to successful implementation. The project team should never stop after ERP software is installed there will be so many tasks that need to be done. Process management activities were highlighted as a most important factor that should start at the pre-implementation stage. To derive useful information about the link between the important factors and stages of ERP implementation all interviewees were asked to specify which factors were more important in each implementation stage. It is clear that almost soft ERP implementation related factors in the case study started from the early stages and continued to the end of the ERP project. It is also important to note that the majority of soft ERP implementation related factors were highlighted as important in the feasibility and planning stages. The importance of these factors lies in helping to align the ERP system with business objectives and in leading to successful implementation. Moreover, there were similarities in the findings regarding soft ERP implementation related factors in the two case study companies under investigation. These similarities were due to the fact that the company belong to the Libyan public sector, and share similar regulations and working environments. It became evident from the interviewees that they reported that the company provides no incentives to encourage the employees to increase their proficiency and to push them to introduce modern techniques, such as the ERP system, into their company. They reported that there also a very important and impressive factor which is directly related to the introduction of ERP system to the oil company. This factor is the National Organisation that controls all the activities related to the oil companies and has a direct connection to the development of systems, regulations and laws which organise oil companies. The interviewees also mentioned that such regulations and laws had not changed or undergone development for many years. The interviewees also stated that experience of working with similar software and selecting an ERP software system, and vendor, are very important factors for successful implementation of an ERP system.

In the initial theoretical framework many key ERP related-factors concerning strategic, organisational and people-related variables were discussed, and these were related to the various implementation stages. These issues were then investigated in the context of the case study company’ environment. A comparison between the theoretical prediction based on the initial theoretical framework and these findings generated from the empirical study shows that there was significant consistency. Meanwhile, from the analysis of the interview results, new soft ERP implementation related factors have been added to the framework, such as motivation and encouragement, developing and revising laws and regulations, and the experience of working with similar software. Moreover, the link between soft ERP implementation related factors and the stages of ERP implementation have been investigated. It has been found that there is an explicit linkage, and consequently the initial theoretical framework has been revised and improved to reflect the case study findings. According to those findings, it is found that different soft ERP implementation related-factors were considered to be more important at different stages of ERP implementation. Therefore, the initial theoretical framework has been revised and improved accordingly. The revised theoretical framework is presented after interpreting the findings from the case study. It includes soft ERP implementation related-factors with specific link to the stages of ERP implementation.

### 8. CONCLUSION

This paper has drawn together material from recent literature, supplemented by evidence from case study; it has provided an overview of the process of developing a theoretical framework that has been proposed so that making the main factors for investigating what the soft factors comprise of the implementation of ERP
system within a Libyan oil company. To reach the objectives of this paper the theoretical framework was developed after a through an extensive literature review on existing frameworks and critical success factors model for ERP implementation. The theoretical framework developed compromises three different factors. These factors were used in the research project, and they are found to be: strategy, people, and organisational factors. The researchers displayed the finding from semi-structured interviews, documents and observations from the case study company. The chosen case study strategy in this research provides valuable in-depth information about soft factors that affect the implementation of ERP system in the case study. Care was taken internally to improve validity by using multiple sources of data and multiple viewpoints, and the case was selected to demonstrate a transition from feasibility studies to pos-implementation stage. The generated ERP related-factors affecting the implementation of ERP system and the link between soft factor and ERP implementation stage that have been pointed in the theoretical framework were studied under the case study environment, they were discussed thoroughly. The comparison between the theoretical findings that were based on the initial framework and those who generated from this empirical study has shown a significant consistency. However, some new other soft factors related to the ERP implementation were revealed. Therefore, based on the findings from case study organisation, the initial theoretical framework has been revised and improved to reflect the case study findings.

REFERENCES

Book

Journal

Conference paper
THE ASPECTS WEIGHTINESS AND INVASIVENESS
IN CONTEXT OF INTEGRATION

Fred Stefan¹, Martin Pero² and Stefan Kühne¹
¹University of Leipzig - Augustusplatz 10, 04109 Leipzig, Germany
²Institute of Applied Informatics (InfAI) - Neumarkt 20, 04109 Leipzig, Germany

ABSTRACT
The integration of different applications constitutes a large challenge in many areas of computer science. Integration projects are important elements of a flexible information technology and essential for flexible business concerns. However, integration projects not often following a clear methodology. In most cases they were done with the means at hand. Anyhow, a misapplied integration approach can get very time-consuming, complex and expensive. The aim of this paper is to emphasize the importance of two essential aspects, which are indispensable for a problem adequate, flexible and customer-oriented integration solution. Specifically, these are the aspects of invasiveness and weightiness.

KEYWORDS
Application Integration, Integration Engineering, Integration Services, Legacy Integration.

1. INTRODUCTION

Information technology is nowadays an essential part of each organization. Over the last decades, organizations have gradually built up an IT environment for supporting their informational and operational needs. Over the past few years, the task of application integration has increasingly worked its way into most information technology departments. The causes are multifaceted and have been driven by a number of emerging developments e.g. the need to expose information hidden in existing systems to the Web, the need to participate in electronic marketplaces, the necessity the integrate customers and partners, and more importantly, just opening up existing enterprise systems to disclose and share information and common processes. Whether you’re talking about, integration creates greater efficiency and sets the stage for future expansion. Organizations that are able to integrate their applications and data sources efficiently, have a distinct competitive advantage. According to Ovum estimates (Ovum 2012), in year 2016 the amount of 14.4 billion USD will be spent worldwide for integration solutions.

Regardless of numerous new developments, many organizations are dependent of application, which were implemented years ago on the basis of mainframe architectures (so-called legacy applications). The lock-in effect is reinforced by years of adaptation to the specific organizational needs. It is estimated that about 10 million man years have been invested in the development of mission-critical mainframe applications (Herrmann and Spruth 2012). For this reason, a replacement of such application systems is not easily possible (Kurbel 2008). To meet today’s business needs, the special field of legacy application integration must be taken into consideration.

Despite a multiplicity of academic process models and highly sophisticated integration suites, integration remains in each area problematic (Forrester 2012). One reason is the lack of a uniform integration methodology, which has been denounced for years (Lublinsky and Farell 2002). In most cases integration solutions were utterly done with the means at hand. Moreover, there is no approach, which explicitly considers the particularities of legacy application integration. This deplorable situation might be remedied with a more systematic and structured design and implementation of integration solutions using engineering like principles in terms of integration engineering (Rautenstrauch 1993). This paper helps to align the integration better to the customer's wishes. For this reason, the importance of the two aspects invasiveness and weightiness will be underlined in detail. If integrators pay due attention to these points, a more problem-
adequate integration solution can be achieved. Finally, suitable evaluation mechanisms allow the comparison of different possible integration solutions.

2. STATE OF THE ART

However, integration projects are often effected by a lot of problems (Sumner 2000), (Lublinsky and Farell 2002) and (Panetto and Molina 2008). Within the academic area a multiplicity of process models exist. Furthermore, the usage of academic approaches in practice remains unclear. To resolve this discrepancy and understand when and why certain methods are used, an empirical study (Gebauer and Stefan 2011) in the form of expert interviews was conducted among 30 German integration service providers. Finally, the study summarizes on over 270 pages the aggregated knowledge and experience of the respondents and presents the current state of the art in the field of system integration. (Gebauer and Stefan 2011b) and the CIO editorial summary (CIO 2011) gives a first brief overview.

First, the study showed that our assumptions completely reflect the reality. Some of the most provocative hypotheses were:

- The more integration service providers are pushed for time, the more unstructured they proceed.
- Operative goals (opposite to strategic goals) drive the creation of integration solutions.
- If acceptable, integration should be as lightweight and minimally-invasive as possible.
- Mainframes are not -- as often declined -- dead. They play a pivotal role in many integration projects.

The analysis showed that the factors of cost, time and flexibility are dominating sizes. In the majority of cases, the integration solution is subordinated to these factors. Accordingly, the integration service providers try to counter this situation by using particularly lightweight approaches. Section 4 discovers precisely what is meant by the aspect weightiness.

Likewise it turned out that Mainframes are not dead. More than two-thirds of the questioned integration service providers are frequently confronted with mainframes during their integration projects. The interviewees described missing interfaces; monolithic and old-fashioned code structure; limited graphical user interface elements; busy development departments; nebulous responsibilities; lack of skills and expertise or minimal, missing, or out-of-date documentation as common problems that emerge when dealing with these integration objects. Since almost all of the mainframe systems represent high clients' investments and incarnate reliability and quality of service, in the majority of cases, grown structures (systems, applications, processes, workflows, etc.) should not or only minimally be invaded. This fact is not limited to the host area, but also applies to other architectures. For this reason, the aspect invasiveness is described in detail in section 3.

3. THE ASPECT INVASIVENESS

Unlike earlier, where the goal of integration was primarily to bring together that which does not fit easily, integration claims today more and more to improve efficiency and productivity. This requires processual, operational and functional changes. Accordingly, integration projects comprise of many different types of activities. Sometimes it is necessary to reorganize the operation (Business Reengineering) to re-designed business processes (Business Process Reengineering), convert databases (Data Migration), to encapsulate existing programs (Program Engineering) to develop interfaces (Interface Engineering), to develop new user interfaces (GUI Development) to develop additional client components, to install new middleware solutions or introduce new standard software.

As the empirical study has shown, the invasiveness term is also well known in practice. Especially in the mainframe area, an approach with minimal invasiveness is of crucial importance. According to the medical area this fact is called minimal-invasiveness. For a better understanding of the basic idea, which stands behind minimally-invasive integration, a little review of medicine history might be helpful. Like no other technology, minimally-invasive surgery caused a sensation in medicine at the end of the 1980's. In comparison to the usual, open surgery, the surgical wound is much smaller. “Keyhole surgery” became a well-known expression, since the access to the operation field is in the most cases not larger than a keyhole.
During the medical intervention, several instruments and a small endoscopic camera were inserted into the operation field and performing the necessary actions. Such a carefully, target-oriented operation is combined with less operational and methodical complexity and reduces significantly the costs of such surgical interventions. In this allegory, the integration should be extensively minimally-invasive - existing processes and systems should be invaded and changed as little as necessary, so that the integration does not jeopardize the operation of the entire organization.

To meet the demand for optimization, it may be necessary to modify existing processes and systems. In literature, the term *invasiveness* is used to describe this fact. In this regard, a fundamental distinction can be made in invasive and non-invasive procedures. Firstly there is a subtle illustration of the invasiveness term. Etymologically, it means the intrusion, invasion or breaking of an existing structure. In the integration theoretical literature, such as in Fincham (1999), Themistocleous et al (2002), Erasala et al (2003), Chowdhury and Iqbal (2004), Endrei et al (2004) and Thränert (2007), the term is used primarily to describe intrusion on applications, interfaces and middleware. It should be noted, that if the term is used, in the rarest of cases, concrete specifics are explained.

But, are applications, interfaces, source code or middleware the only elements that can be invaded by an integration? Assuming that an information system is a socio-economic system, further elements can be identified, that may be affected by the integration. Information systems include, in addition to the IT system, also the organizational structure, in which the system is embedded and moreover the people who work with the system.

On closer inspection, an information system can be distinguished in two subsystems: the Socio-economic subsystem and the IT subsystem. The Socio-economic subsystem includes human components, processes, organizational rules as well as all other infrastructure components. Any hardware and software components of an organization can be subsumed under the IT subsystem. Accordingly, the IT subsystem can still be divided into the software subsystem and the hardware subsystem. The software subsystem includes besides application software, basic software like operating systems, application servers, middleware, communication software, databases, web servers, without which the application software can not run. As the second subsystem of the IT subsystem, the hardware subsystem can be divided into major components and other hardware components. For instance, computer represent a necessary major component which is required for the execution of the software subsystem. At the same time, other hardware components, such as cables, adapters, etc. may be necessary for information provision and dissemination.

But what does now exactly invasiveness means? The invasiveness of integration is determined by the degree of intrusion and change on each components element of an information systems subsystems. Each element can be invaded in different manner. Three basic operations are possible: creation, elimination and adaption. The adaption can be drilled down further into the operations: restructuring, extension and removal.

Having clarified What can How be invaded, it seems important to be able to determine How much. Quantifiable sizes allow the comparison in terms of invasiveness of different integration solutions. Appropriate metrics can be derived with the Goal Question Metric (GQM) approach (Basili and Weiss 1984).

4. THE ASPECT WEIGHTINESS

In addition to numerous technical challenges, integrators are also confronted with a number of organizational and political challenges, which are primarily limited by the factors costs and time. At the same time, customers expect from the integrators a certain flexibility to respond in course of the project to initially unclear requirements and possible changes during the project. Obviously, the manner in which the integration is carried out, is in addition to the invasiveness of significance as well. The headwords cost reduction, shorter project run times, little planning, accepted risks and enhanced agility are consistent with the examination of the weightiness aspect in context of integration.

A few years ago, the software engineering was faced with similar challenges. The obvious dichotomy between rigid, traditional process models and the effort to respond more effectively the customer's requirements, caused a lot of discussion. Finally, the software engineering encountered these challenge with so-called lightweight methods. They form the basis to examine these paradigms in the context of integration in more detail and to draw benefits for the integration. Finally some of these lightweight paradigms from software engineering are already implicitly applied by some integration service providers.
Neither in the software theoretical nor in the integration theoretical literature a common understanding of lightweight methodologies exists. In addition, a precise delineation of process models is extremely difficult due to the enormous variety, as well as the general complexity of software development. A multiplicity of (integration) process models with the most diverse interests exists. However, in the literature and in practice, a common understanding about the weightiness of a number of well known process models exists. Representatives for lightweight approaches are for instance: Crystal, Scrum, or XP. Contrary, the V-Model and the Waterfall model belong to the heavyweights. An empiric-driven dimensional analysis derived characteristic features of lightweight approaches. These features represent a diversity of appropriate dimension candidates, including their characteristics. On the basis of these dimensions, (integration) process models can be compared with regard to their weightiness.

For a clear graphical representation, a polar diagram was designed. There are seven dimensions of weightiness, which are in form of axes placed around a central point. Corresponding to the characteristics of the examined dimension, fields can be marked on the axes. Different shades can add additional information on the characteristics of the dimensions. The following cases are possible: total agreement (the fields are filled black), no agreement (the fields are left white), partial agreement (the fields are shaded). Some dimensions have characteristics that may occur simply to multiple (e.g. the approach strategy can be incremental, iterative, and prototypical). Therefore several fields on the dimension axis will be shaded. The position of the shaded fields indicates the process models weightiness. If the majority of marked characteristics are close to the center, it is a clear indication for a lightweight process model. Likewise a large number of marked characteristics in the outer circle indicates a heavyweight process model. Since some aspects, such as a user participation are not clearly classifiable, a neutral area was introduced between the two layers. Marked characteristics of this layer have a case by case based influence on the evaluation of a process model.

With the help of this diagram, many process models, both scientific and practical origin, were analyzed for their weightiness. Thus, the graphical comparison framework allows the integrators a closer consideration on different process models, to better meet customer requirements.

5. CONCLUSION AND FURTHER WORK

The aim of this paper was to emphasize the importance of the aspects weightiness and invasiveness in context of integration. The practical needs of even lightweight and minimally-invasive concepts were deduced by an empirical study. The description of the aspects invasiveness and weightiness allows a better assessment of alternative integration solutions. Differences between the solutions are getting more recognizable and apples are no longer considered as oranges. These advances open up new opportunities for integration service providers. They can plan their services better and remove unattractive, such as invasive services from the program. Thus, solutions can be tailored more focused on customer needs.

Naturally, integration projects touch many business and technical aspects within the organizations. However, it turns out, that not only technical challenges influence integration projects. Additional important challenges span far across business and technical issues. Integration projects require a significant slow hand and a gentle touch during the introduction. Additionally, integration projects need a certain flexibility, to adapt to changing business needs and dynamic markets. In this context, particular lightweight integration approaches have been outlined. The benefits of particular lightweight and minimally-invasive concepts are closely aligned to business benefits: getting a problem-adequate solution and saving costs and time.

In addition further research need exists regarding a comprehensive conceptualization of the aspects weightiness and invasiveness. Furthermore, appropriate presentation methods and metrics need to be developed. The metrics can be evaluated in our integration laboratory. We use this laboratory environment for quite some time to examine methods and tools for the integration of business information systems. A central component of the laboratory environment is an IBM z9 mainframe. Thus even legacy applications can be examined in their original environment. Such a setup is a unique feature, since only two European universities have their own mainframe installation for research and educational purposes. Supplemented by various virtualization solutions, we combined further integration objects (such as ERP, CRM, or shop systems) as well as middleware solutions and integration tools to realistic integration flows. On the basis of various case studies, particularly minimally-invasive integration concepts can be developed and evaluated.
Further research has to be done outside of this work include the development of mechanisms for monitoring the integration solutions and the mapping of the technical results on business processes. Therefore enterprise architecture models such as ArchiMate can be used.

ACKNOWLEDGEMENT

The work presented in this paper is undertaken as a part of the EUMONIS project (01IS10033K). EUMONIS is funded by the German Federal Ministry of Education and Research (BMBF).

REFERENCES


Rautenstrauch, C., 1993: *Integration Engineering*. Addison-Wesley, Bonn


AN INVESTIGATION OF THE CONTEXTUAL FACTORS AFFECTING THE IMPLEMENTATION OF QUALITY MANAGEMENT IN IT DEPARTMENTS IN SAUDI ARABIA

Khalid I. AlShitri¹ and Abdulmohsen Abanumy²

¹National Satellite Technology Center, King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia
²ICT Department, King Fahed Security College (KFSC), Riyadh, Saudi Arabia

ABSTRACT
The main purpose of this paper is to investigate which contextual factors are important to consider when implementing quality management principles in IT departments. This paper starts by exploring the factors affect quality management implementation in all types of organizations and within all management levels then explain the research method that followed to conduct this study and then identify and discuss the research finding then conclude by present the recommendation that organizations should give the factors a consideration when developing their implementation approaches, and provides a guideline to show how these factors are likely to affect the implementation of quality management in IT departments.

KEYWORDS
Information technology, quality management, change management, and Saudi Arabia.

1. INTRODUCTION
The current state of the art in quality management has been shaped by quality experts such as Deming (Deming, 1986), Juran (Juran and Godfrey, 1998), Crosby (Crosby, 1996), Feigenbaum (Feigenbaum, 1991), and Ishikawa (Ishikawa, 1985), and their quality approaches. Quality management is a philosophy integrating humanistic principles as well as scientific methodologies for the purpose of continuous improvement (Parzinger and Nath, 1998). It refers to a set of management concepts and processes that emphasize continuous improvement for achieving efficiency and effectiveness. Quality management is, compared to other concepts such as quality control and quality assurance, wider since it embraces the whole organization instead of focusing on parts of the product. Therefore, the implementation of quality management has the potential to impact upon an organization’s culture and structure, necessitate the redesign of business processes, individual tasks and job descriptions, engender changes in the behavior and attitudes of individual employees, and alter the distribution of power.

The introduction and the implementation of quality management in organizations are subject to failure. The review of literature has shed some light and identified several social, economical, and technical factors which may hinder and slow quality management implementation in organizational level (Benson et al. 1991; Ghobadian and Gallear 1996; Masters 1996; Zabada et al. 1998; Yong and Wilkinson 1999; Fok et al. 2001; Ljungstrom and Kleveland 2002; Sebastiannelli and Tamimi 2003). One possible reason for some of the unsuccessful quality management implementation is the possibility that quality management implementation is context-dependent. That is, contextual factors e.g. organization size might play a role in the successful implementation of quality management practices. However, this issue has largely been ignored in the literature (Sila 2007).

Despite the number of publications and the amount of research into quality management, little empirical work has been carried out in developing countries (Baidoun and Zairi, 2003). This is particularly true of the Arab world and Saudi Arabia specifically. From the researchers’ own experience as well as the limited research and the points raised by (Al-Sulimani and Sharad, 1994, Youssef and Zairi, 1995, Al-Omaim, 2002), the region (and Saudi Arabia in particular) is a long way from maturity in terms of quality practices and
organizational culture and climate that are needed to implement quality management. Quality management cannot work in an environment in which the systems/practices are hostile to its teaching. It is not enough to describe where Saudi Arabia industries should be, but to know where they are before deciding how to move ahead. In their studies, Al-shitri and Mayhew (Al-shitri and Mayhew 2008a; Al-shitri and Mayhew 2008b) investigated the level of implementation of the quality management in IT departments in the Saudi Arabian private organizations and found that there were lack of some of the quality management implementation practices. Also, they obtained mixed results about the success and failure quality management implementation between different organizations. Thus, the objective of this study is to explore the contextual factors that effects quality management implementation in the IT departments in Saudi Arabia.

To summarize, the importance of quality management in practice, the lack of research and the need to develop knowledge specifically for the benefit of organizations outside the developed economies in general and in Saudi Arabia in particular, and the lack of quality management implementation in IT departments, indicates that expanding the existing knowledge of quality management implementation to the IT field is a valid topic for research. The objective of this study is to identify the contextual factors that may affect quality management implementation in IT departments in Saudi Arabian organizations by examining and understanding the context in which quality management where implemented, in order to recognize the problems faced and to suggest a way forward. Achieving the above aim will contribute to a deeper understanding of the obstacles to quality management implementation in IT departments. This would help academics and practitioners in the investigating the factors that affect quality management implementation in IT departments and to propose an implementation framework that could help IT departments to overcome the increased pressure for high quality information systems due to global competition, customers demand, company survival, and pervasiveness of IT in modern organizations.

2. METHODOLOGY AND FINDINGS

2.1 Research Method

The main purpose of this study was to explore the contextual factors affecting quality management implementation in IT departments in Saudi Arabian organizations. For this purpose, a semi-structured interview was used to enrich the study’s findings through open-ended questions. The prime method used to collect data was to ask the interviewee which characteristics of his organization influenced the implementation or effectiveness of the quality management. This was followed by further questioning to obtain details on the difficulties experienced during implementation. After completion of the interviews, similar factors affecting quality management implementation in IT departments were grouped together, enabling the identification of the most common factors. In selecting the organizations to take part in the interviews, only those who had at least 3 years experience of quality management implementation were chosen. The reason for the three-year time limit was to identify and examine the organizations with significant levels of practical experience. Twelve organizations that varied in their business category and size were selected.

The researcher conducted interviews with twelve IT managers. The interviews were always informal, being conducted in Arabic or English. Participating organizations were assured of their anonymity. None of the semi-structured interviews were tape recorded. So, notes were taken. The agreed time of each interview was one hour. After the researcher had introduced himself to the respondent, the researcher described the aims of the study and the purpose of the interview. The researcher conducted the interview during working hours. This caused difficulties as sometimes the interview process was interrupted due to an urgent situation related to interviewee’s work.

After the interview process with the IT managers had finished, the researcher started to analyze interviewees’ answers. The researcher transcribed the results in the form of table, calling this the ‘influencing factors table’. The ‘influencing factors table’ consists of rows and columns; the columns include the human factors that influencing ISO9001 implementation in IT departments in the Saudi Arabian private organizations and the rows list the IT managers by number, “IT managers_1”, etc. In the data transcribing process, the researcher marked (✓) when the IT manager mentioned one of the factors that were listed in the interview results table. If, however, the interviewee suggested a new factor, the researcher added it to the
table. The researcher also wrote down the interviewees’ comments about each factor. After transcribing the interview answers, the researchers reviewed these answers with the interviewee in order to confirm it and avoid any misinterpretation of the interview answers. After the process of transcribing the interview results finished, the data analysis process started in order to identify the factors which have the most influence on ISO9001 implementation in IT departments in Saudi Arabian organizations.

2.2 Findings and Discussion

All interviewed organizations have ISO9001:2000 certificate at organizational level and only two organizations implement formal quality management and obtained ISO9001:2000 certification at IT department level. These two organizations showed an advanced level of quality management implementation practices. Four organizations have a distinct quality function/department within the IT department. IT is playing a strategic role in the organizations visited. IT are used to increase accuracy, consistency, providing visibility, thus improving performance, efficiency, and reducing the cost of their operations. In relation to IT infrastructure in those organizations, all have Local Area Networks (LAN), and up to date servers and operating systems. IT are dispersed all over the organizations. All of those organizations implemented Off-the-Shelf (Enterprise Resource Planning (ERP) and/or Manufacturing Resource Planning (MRP) solutions) to managing their business processes. Some of them had implemented these ERP without any customizations and some of them are also developing systems in-house.

The interviews with the IT managers suggested that the following contextual factors may lead to quality management implementation failure in IT departments:

2.2.1 IT Department Size

The size of the organization was identified as one of the obstacles for successfully implementing quality management (Ghobadian and Gallear, 1996). In IT departments, individuals are often responsible for a number of different functions with little backup. They are busy with managing the day-to-day activities and have little time left for quality management activities. Thus, sending them for training is difficult decision. The small IT departments in terms of number of employees made the practice of quality management difficult and limit its possibility for success. Most interviewees stated that staffing in their IT departments was inadequate even for managing their daily activities. To counter this, a number of employees worked in their own time on continual improvement projects.

2.2.2 Lack of Time

Time, or rather the lack of it, is often cited as a key reason for organizations not pursuing quality management initiatives (Yong and Wilkinson, 1999). Finding time is one of the main problems in the early stages of quality management programs as the IT managers are too busy fire fighting to find the time for quality management implementation. Lack of time was mentioned as an important obstacle to the introduction of quality management in IT departments in Saudi Arabian organizations. It hampered efforts to formalize and improve business procedures, attendance at team meetings and training courses, and analysis of results and problem solving. To counter this, a number of employees worked in their own time on continual improvement projects.

2.2.3 Frequent Employees Turnover

Turnover of employees disturbs the organizational routine of organizations which makes change-management initiatives like quality management difficult to develop successfully (Yong and Wilkinson, 1999). While a documented manual can serve a company well in the light of employees’ turnover, it needs to be said that documentation is of limited use when the jobs are demanding or fast-paced such as IT; in such circumstances, written procedures and processes would not supply all the correct information or be accessed quickly enough. In this study, the interviewees agreed that IT employees turnover rate was high. Employees leave their jobs in search of better pay, working conditions, and greater job satisfaction, creating a discontinuity in an organization’s quality management efforts and its daily working routine. Experience indicates that more extensive screening processes prior to hiring, training, and reward systems tend to lower turnover rates.
2.2.4 Shortage of Skills

Another factor that compounds the high turnover problem is the shortage of IT and quality management professionals. With an acute shortage of IT professionals, Saudi Arabian organizations have resorted to hiring semi-skilled and unskilled workers and then training them. Skilled employees are likely to accept quality management more quickly than lower skilled employees. They are less likely to feel threatened by proposed changes and are more likely to understand its need. Organizations wishing to increase the autonomy of their workforce may need to improve the skill level of their employees. To solve this problem, some Saudi Arabian organizations have resorted to hiring IT and quality professionals from foreign countries.

2.2.5 Business Type

The results show organizations from the manufacturing sector were more successful in implementing quality management in their IT departments more than organizations from other business sectors. Increasing local and international competitions, market globalization, and public demand are driving many manufacturing organizations to implement new methods to improve productivity and efficiency. However, organizations from the manufacturing and financial sectors were found to be having more experience in quality management implementations in IT departments. They allocate sufficient budget for training and education, improving business processes, and providing advanced IT infrastructure. They also allocate sufficient budget for establishing a quality management unit within the IT departments and hiring highly skilled quality management professionals who are dedicated to monitor, measure, and improve IT processes, products, and services.

3. CONCLUSION

The purpose of this study is to explore contextual factors that affect the successful implementation of quality management. It extends previous research in this area in two ways. First, these interviews focus on examining the issues that is associated with managing the quality management implementation. This follows directly from a review of the relevant literature, which indicates that most obstacles to quality management implementation can be linked directly to ineffective change management. Second, this study explores how these factors relate to potential undesirable outcomes of failed quality management implementation projects.

This study identified five contextual factors affecting the implementation of quality management in IT departments. These are: the size of the IT department, lack of time, frequent turnover of employees, and shortage of expertise, and business category. The findings have shown that there is a complex relationship between the contextual factors and the quality management implementation activities in the IT departments. Therefore, organizations must constantly be aware that these issues are critical to quality management implementation success.

It is hoped that, in the future, research will concentrate on exploring these relationships in greater detail and identify the common contextual factors for different sectors; evaluate the level of criticality of each of these factors; investigate the relationships between changes in criticality of these issues with changes in an organization’s level of experience in implementing and operationalizing of quality management principles.

REFERENCES


ISSUES ASSOCIATED WITH CITIZENS IN DEVELOPING COUNTRIES TRUSTING THE SECURITY OF ON-LINE SERVICES

Ahmad Alenezi1 and Saad Amin2
1Department of Computer Science and Technology - University of Bedfordshire - Park Square, Luton, Bedfordshire, LU1 3JU, UK
2Department of Computer Science - Coventry University - Priory Street, Coventry, CV1 5FB, UK

ABSTRACT
This paper explores the reasons behind the lack of trust in the security of those online services, which are provided by governments and commercial organisations. Based on the analysis of data collected, the researchers were able to identify some of the important barriers and challenges arising in this context. As a result, this study has generated a list of possible recommendations that can help to solve this issue.

KEYWORDS
Trust, E-Trust, Online Services

1. INTRODUCTION
Lack of adequate security systems on the Internet, especially in government and commercial websites, may cause citizens to lose trust in online services or their trust to reduce to levels that online service providers may not prefer. In recent years, many governments and companies have transitioned to online services and transactions. Trust in online security is one of the most serious issues users claim to consider when using online services. Such issues are likely to affect citizens’ trust in E-government or E-commerce; something that has been of great concern to commercial and government organizations alike. Lack of confidence in online services is of great concern, especially when the result is refusal to take advantage of the benefits inherent in transitioning to online services. The reasons behind this will be discussed later in this paper.

2. BACKGROUND
In general, Trust is a subjective expectation an agent has about another’s future behavior based on the history of their encounters [Mui et al, 2002]. The definition of e-trust (online trust) in an electronic commerce environment remains ambiguous. [Bart al et, 2005] stated that “online trust includes consumer perception of how the site would deliver on expectation, how believable the site’s information is, and the level of confidence in site”. Empirical research in e-services reveals that e-trust positively and directly affects customer satisfaction [Kim et al., 2008; Liao and Wu, 2009; Kim and Swinney, 2009].

3. LITERATURE REVIEW
In recent years, many governments and companies have transitioned to online services and transactions. This transition to online services and transactions has numerous benefits. For example, online means are more accurate, simple, efficient, cost effective, and there is a reduction on use of papers, and time saving. On the other hand, using online services for government or commercial transactions has some disadvantages. These
disadvantages include failure to implement successful online services in some places, lack of knowledge and ability to use computers, lack of security and privacy of information in websites, as well as the issue of trust in online services [Ebrahim and Irani 2005].

4. RESEARCH METHODOLOGY

In this study, a quantitative research method using questionnaires was applied. The questions were designed to discover the behaviour of normal citizens in relation to the problems they face while using online services especially in side of trusting online services security. The questionnaire was sent to about 400 users in Saudi Arabia and the number of the respond is 202 responds.

4.1 Data Collection Results

In this study, the quantitative research method of using questionnaires was applied. Clear questions were designed so as to discover the behavior of normal citizens in relation to problems they face while using online services. The following sections highlight the main findings and provide indications as to how the research question might be answered based on the survey results.

Table 1. Shows data collection results

<table>
<thead>
<tr>
<th>Age</th>
<th>Under 18</th>
<th>18-25</th>
<th>26-35</th>
<th>50-36</th>
<th>Over 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education Level</td>
<td>Primary 1%</td>
<td>Interme</td>
<td>Secondary 22.8%</td>
<td>Graduated 66.3%</td>
<td>Post Graduated 7.9%</td>
</tr>
<tr>
<td>Using E-G Transactions Before</td>
<td>Yes 64.7%</td>
<td>No 35.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confident to give Personal Info to online providers</td>
<td>Yes 38.5</td>
<td>No 61.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trusting in Security of websites of being attacked</td>
<td>I do trust 28.2%</td>
<td>Strongly Trust 5.01%</td>
<td>Neutral 35.0%</td>
<td>I do not trust 18.8%</td>
<td>Strongly do not trust 12.8%</td>
</tr>
<tr>
<td>Awareness of the risks related to information and the Internet security</td>
<td>Excellent 6.9%</td>
<td>Good 42.2%</td>
<td>Poor 50.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not trust online transactions</td>
<td>Agree 24.43%</td>
<td>Disagree 62.60%</td>
<td>Neutral 12.98%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. FINDINGS AND ANALYSIS

The following model shows some of the main points which affect citizen's trust in online services security both positively and negatively. The next paragraph will explain these points in more detail.

Figure 1. The main points effecting trust in the security of online services
6. CYBER CRIMES

After falling victim to some of the serious effects of cyber crimes, most developed countries have now established cybercrime laws to deal with those found to have committed cyber crimes. Similarly, developing countries have recently started to establish new laws along these lines. Saudi Arabia, as a developing country, established cybercrime law late in 2007 in recognition of the need to address this issue [Bureau of Experts at the Council of Ministers, 2009]. Dealing with cyber crimes through the use of strong laws to punish attackers will hopefully prevent most potential hackers from engaging in fraud over the Internet, thereby increasing trust amongst citizens with regards to the security of online services [Bainbridge, 2004 ].

6.1 Security Mechanisms

Following an increase in the number of cyber crimes on the Internet, Internet security has become a prominent online service routinely provided to users. The responsibility for guaranteeing onsite security is held by the services providers themselves; regardless of whether they are Governments or Commercial organisations. Thus, must providers follow the security procedures to keep their websites safe and secure to be used by users [Arkko et al., 2003]. Thus, failure in applying these mechanisms results in many of the problems that exist in Internet security especially with regards to users’ behaviour when trusting online services security. On the other hand, applying these procedures successfully make users more confident and also even more trusting when using online services.

6.2 Confidentiality, Integrity and Availability (CIA)

CIA defines the key components of information security and is discussed in reference to security mechanisms. As a consequence of the data collection process, the researcher discovered that there are high numbers of users afraid of those points which affect trust in online services security. This also shows that users are not sufficiently aware of how best to identify how to ensure that their personal information is safe and secure from being stolen, modified or accessed by an unauthorised party. This kind of behaviour leads users to lose confidence in regards to online security [Shiu, 2011 ]. According to the data collected and following the analysis process, the researcher realised that lack of understanding is the issue most likely to cause citizens to lack confidence in the security of online services. It is the role of Internet services providers to guarantee that users’ information will not be stolen, modified or accessed by unauthorised parties.

6.4 Confidentiality, Integrity and Availability (CIA)

According to the data collected and following the analysis process, the researcher realised that lack of understanding is the issue most likely to cause citizens to lack confidence in the security of online services. It is the role of Internet services providers to guarantee that users’ information will not be stolen, modified or accessed by unauthorised parties. According to a number of researchers, there is a clear relationship between educational level and willingness to use technology based services [Chen et al, 2006]. It has been observed that people who have a higher level of education or hold higher level certificates tend to use Internet services more. This group appears to feel more confident and therefore is more trusting of online services than other users. On the other hand, people who have a low educational level appear to have trust in online services security. There some explanations available to explain this phenomenon; for instance: lack of ability to use the technology, and lack of a basic knowledge regarding what security procedures to follow to avoid becoming victims of cyber crimes. Finally, as also shown in this study, reduced trust in online services can be as a result of one’s age group. For instance, a high proportion of those respondents aged over 50 years lacked the ability to use Internet services and therefore did not trust online services.

6.5 Cultural Background

Over the last two decades, the use of technological services has become a global phenomenon [Homburg, 2008]. The main reasons cited for offering such services uniformly to all citizens are their supposed
educational and economic benefits. In developed countries, people are more able to accept and deal with exposure to technology. Governments in these countries are spending money to ensure that all their citizens are aware of the benefits associated with the use of the technology and especially online services. On the other hand, some individuals in developing countries remain unaware of the real benefits of using technology, in particular Internet technology [Zaied et al, 2007]. Based on the collected data, it can be seen that cultural background is one reason preventing people from trusting online services; especially the issue of trust in the security of such services [Zaied et al, 2007].

6.6 Successful Application of Online Services

Over the last decade, provision of online services has become more widespread and volume of usage has increased in the forms of both E-government and E-commerce [Homburg, 2008. As mentioned, there are clear differences in terms of quality when applying these services successfully and correctly. Countries like Singapore, Canada, the United States and the United Kingdom are leading the way in applying perfect online services to their citizens. Their success with providing excellent services to users allows them to be able to use such services confidently and safely. This experience leads citizens to have more trust in online services security, especially when using online services provided by both E-government and/or E-commerce [Dunleavy, 2002]. Many developing countries are facing a lot of problems in applying online services to their citizens either in the E-government or E-commerce [Ebrahim and Irani, 2005]. As a result of the failure to apply online services successfully, some citizens have lost their confidence, and discussions over security have dominated. Analysis of the collected data shows that many people are disassociating themselves with the use of online services, as a response to the fear that their personal information may end up being compromised by being disseminated on the Internet [Ndou, 2004].

7. RECOMMENDATIONS

After searching for information, discussing and analysing the information, recommendations have been developed so that the current security issues regarding online services can be resolved. Governments and private organisations should address the issues related to Internet security so as to increase the confidence of online users. The following are some important recommendations that should be implemented: Firstly, the government should raise awareness of the concepts of E-government and its benefits and urge citizens to transition to online services and transactions [Chen et al, 2006]. Further, the government should protect its online systems by using advanced security systems to retain systems security and safety for use by citizens. Secondly, the government should implement tougher penalties for cyber crime so as to deter online attackers from undertaking fraudulent activities. Fourthly, developing countries should increase their efforts in developing and improving the online services provided to their citizens [Heeks 2001]. Finally, in addition to focusing on systems’ security, the government should provide an excellent infrastructure, so that the use of online services can be both secure, and available to all citizens.

8. CONCLUSIONS

In conclusion, it apparent that people have mixed reasons for failing to trust in online services. For instance, the mode of providing the online services can affect the trust of the people being provided with those services. Citizen’s adoption of online services is an important goal for many governmental online service providers; however, security and trust issues still represent huge challenges. Governments must be aware of the lack of Internet security, and the impact of this on the trust citizens have in online services. Citizens should follow all necessary security measures to keep their devices secure and protected from attack. With the increase in the number of online attacks over the past few years, many citizens have lost their trust in
online services. Therefore, the government should implement stricter penalties for online attackers so as to deter them from committing further crimes.

REFERENCES


Bainbridge, D. (2004), Introduction to computer law, fifth ed, Great Britain, British library


WHO ARE WE? IDENTIFYING AND DEFINING THE INFORMATION SYSTEMS (IS) DISCIPLINE BY A SET OF PRINCIPLES

Deborah Bunker
University of Sydney Business School

ABSTRACT
This paper seeks to develop some guiding principles which underpin how we might come to identify the IS discipline and define the IS artifact and paradigm. It is argued that as these principles define the IS artifact and paradigm from an informational perspective and that they decouple this definition from the physical attributes of information and communications technology (ICT) artifacts and the associated paradigm of Engineering. In this way, we are more effectively able to identify and differentiate who we are and what it is that we contribute within our discipline.

KEYWORDS
Information systems (IS), identity, discipline, artifact, paradigm, information and communications technology (ICT)

1. THE DEFINITION OF THE IS PARADIGM AND OUR DISCIPLINARY IDENTITY

“Identity [C, U] the characteristics, feelings or beliefs that distinguish people from others: a sense of national / cultural / personal / group identity”

What are information systems (IS)? This is not an easy question to answer and IS academics have been struggling for many years to define the IS paradigm (and hence identify the discipline) in order to highlight its relevance to the world in which we live (Benbaset & Zmud 2003). A paradigm as defined by Kuhn (1970) is “…the universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners – page viii”. It is the purpose of this paper to articulate a set of principles that may assist us to define the IS paradigm so as to develop our disciplinary identity.

IS are at the core of our survival on a day-to-day basis and are a mediating force in our relationships with others. They are important for market positioning, efficient and effective operation of organizations, and they underpin our local and global activities as societies. They are at the heart of all we know and assist us to define who we are. It is very important, therefore, to have an understanding and appreciation of how IS make this contribution to our human condition. IS have been with us from the very beginning of human society and in fact, we would not be able to survive and function as individuals, organizations or societies, without the (relatively) free exchange of information and its systematic use.

The Oxford English Dictionary (http://www.askoxford.com/) defines firstly, information and then system, (as there is no definition for IS) and we see that information is “the action of informing (verb); formation or molding of the mind or character, training, instruction, teaching; communication of instructive knowledge” and system “a set of principles, etc.; a scheme, method. The set of correlated principles, ideas, or statements belonging to some department of knowledge or belief; a department of knowledge or belief considered as an organized whole; a connected and regularly arranged scheme of the whole of some subject; a comprehensive body of doctrines, conclusions, speculations, or theses”.

It could be argued therefore, that IS may be defined as “the action of informing through the application of a set of principles, etc.; a scheme, method”. Where does this leave our notion of the IS paradigm? Thomas Kuhn states that “Acquisition of a paradigm and of the more esoteric type of research it permits is a sign of maturity in the development of any given scientific field”. As IS academics, however, we are still vigorously debating how we identify our discipline, which is evident not only by the large breadth of research and...
publications in the area, but also by radical university structuring and restructuring of IS departments and the curricula debates that are occurring worldwide.

We still also struggle to explain what it is we do to those outside our discipline, so how can we best define the IS paradigm, structurally underpin our discipline and communicate our identity and importance to outsiders? A recent answer to this question has been for the discipline to focus on issues of “socio-materiality” and the move to express the idea of IS as an entanglement of technology, people and context. “...there is an inherent inseparability between the technical and the social” (Orlikowski & Scott 2008). These new developments, while providing some interesting research directions, do little to help the IS discipline with the practical matter of identity and survival.

As we cast our eyes to the ICT discipline of Engineering, there does not seem to be the same struggle for identity or a definition of the research paradigm. Within the Australian context we have recently had the establishment of the Australian Council of Deans of ICT (http://www.acdict.edu.au/) which is instrumental in articulating the importance of the ICT artifact and the contributions of the Engineering paradigm to that Discipline’s identity. At the same time, however, IS academics are having difficulty in defining and articulating the IS paradigm, as IS may not always be defined in terms of the ICT artifact, and almost always needs to invoke inter-disciplinary paradigmatic knowledge from Engineering/Psychology/Business Studies/Sociology etc in order to further the IS research agenda and build the IS body of knowledge.

2. DEFINING THE IS PARADIGM: THE DEBATE

The heart of the debate is centered on how we define the IS artifact, much as the Engineers view their paradigm and contributions though the ICT artifact. Ancient civilizations had their IS artifacts (cave paintings and hieroglyphs etc), and more recent civilizations have iPads, smart phones and Facebook. Recent developments in computing technology have made ICT based IS more pervasive and difficult to separate from their users, and the propagation and use of information is faster than ever, but never-the-less we have always been reliant on IS as individuals, organizations and societies even before the relatively recent advent of ICT based IS.

Figure 1 shows that the world average for internet adoption is currently low at 34.3% of global population. Yet information is still central to the way all individuals survive, so why is the IS discipline preoccupied with ICT based artifacts? Could this be to our detriment by confusing our identity with that of our Engineering colleagues, while also leaving many non-ICT based IS research problems under-researched?

We have argued (as a discipline?) for many years about our identity (Gorry & Scott- Morton, 1971; Davis, 1974; Zmud, 1978; Mason & Mitroff, 1981; Culnan, 1987; Banville & Landry, 1989; Orlikowski & Iacono, 2001; Galliers, 2003; Weber, 2003; Hirschheim & Klein, 2003; Alter, 2003; Benbaset & Zmud, 2003; CAIS IS Core Series, 2003; Agarwal & Lucas 2005 ). From a review of these papers we can see that the debate in identifying IS has mainly focused around defining the IS artifact and the social context in which it is situated. Topics have included:

- Defining core beliefs (identity): can IS be narrow and focused versus broad and all encompassing;
should IS have a narrowly defined core (attributes of the ICT artifact); does IS need to be “disciplined” at all and is this contrary to what we believe we contribute to practice; does IS need core beliefs to maintain an identity?

- **Maintaining diversity (positioning)**: how does IS relate to and be part of other disciplines; is IS a “broad church” (business and technical); does IS add value to other disciplines (ES, supply chain management); were there early “tell tale” signs that indicated a lack of discipline identity (IS scholars had diverse disciplinary training and backgrounds in the beginning)?

- **Deriving agreement and consensus on the IS body of knowledge (BoK)**: how do we train IS practitioners and academics?

- **IT artifact as the discipline (boundary)**: how do we define the ICT artifact and use this to define the IS paradigm; what are the technical/structural attributes, design attributes, application attributes, and management attributes etc of IS; what is the relevancy of the ICT artifact to the majority of the world’s population; what constitutes the ICT artifact?

- **Defining the nature of the discipline (inter, multi and trans disciplinary identity) – also see core beliefs (above)**: is IS discipline identity created through interactions with other disciplines; is there a dilution of core principles, rigor and relevance (internally and externally to IS) when boundary spanning is out of control (legitimacy, relevance and positioning); is IS all things to all people” (identity) and is this is our strength (rather than a weakness)?

- **Business focus (context and relevance)**: is there a business versus individual versus societal research in a business context (which assumes that business is our main source of legitimacy & our research territory); why is there difficulty in publishing research outside of this focus in mainstream IS outlets of high quality (complicity); and why do many current problems for IS contributions lie outside of the business focus i.e. green issues; societal change; humanitarian issues etc (relevancy)?

- **BoK and publishing (legitimacy)**: why do our main journals in the field (top tier) reflect a multi-disciplinary focus i.e. our top journals are sometimes closely identified with IS and are sometimes not?

Most of the argument, however, has not really advanced the cause of IS and has not effectively addressed, in practical terms, the notion of disciplinary identity. IS is still confused with ICT and in many cases the terms are used interchangeably. As a result IS departments in Australia are still being closed or merged with other areas of their universities (often Engineering), practitioners are still ignoring our research (by and large), and students and their parents still scratch their heads in confusion as we attempt to explain to them what an IS professional does. Perhaps a way through this confusion is to define and differentiate the IS artifact from the ICT artifact and thus redefine the IS paradigm in order to better identify ourselves.

### 3. DEFINING THE IS ARTIFACT AND DEVELOPING OUR IDENTITY: TEN PRINCIPLES

“first principles noun [pl.] the basic ideas on which a theory (theorising), system or method is based: i.e. I think we should go back to first principles”.

Our survival depends on our ability to clearly identify the IS discipline, and the practical skills and outcomes we can offer for practitioners and by association, our graduates. We must then be able to clearly articulate this to our universities, and the businesses and societies that they serve. In light of our history as a discipline, previously outlined in Section 2, our challenge is to identify the IS discipline in a way that is not bound by the definition of the artifact at its core. How can we develop our disciplinary identity by focusing on the development of theories and approaches about the systematic action of informing that are not necessarily framed around and dominated by the ICT artifact, as has occurred thus far?

The answer may lie in focusing our attention on the informational characteristics of the IS artifact rather than its physical properties. In developing the following ten principles of the IS artifact underpinned by informational characteristics rather than physical properties, we are able to transcend the physical bounds and definitions of ICT and the Engineering paradigm, and develop our own unique and relevant identity. The IS principles outlined in Table 1 reflect a definition of the IS artifact across the informational characteristics of: ubiquitousness; influence on individual and group behaviour; impact on the process of doing things; impact on technology and organizational structures; competitive advantage; systems development, inheritance and security as well as the inter-disciplinary nature of IS research.
Table 1. IS Principles

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IS are ubiquitous</td>
</tr>
<tr>
<td>2</td>
<td>IS impact the one and the many (individual and group/social behaviour)</td>
</tr>
<tr>
<td>3</td>
<td>IS impact the way things are done (processes)</td>
</tr>
<tr>
<td>4</td>
<td>IS may, or may not, have ICT artifact-based components (technology – general term)</td>
</tr>
<tr>
<td>5</td>
<td>IS are determined by strategies employed and advantages gained (structures)</td>
</tr>
<tr>
<td>6</td>
<td>IS facilitate strategies for survival and competitive advantage (advantages)</td>
</tr>
<tr>
<td>7</td>
<td>IS must be agreed to and then developed using common protocols, methods and/or materials (development)</td>
</tr>
<tr>
<td>8</td>
<td>IS must be inherited, managed, maintained and passed on (inheritance)</td>
</tr>
<tr>
<td>9</td>
<td>IS must be secured to prevent “outsiders” from “free-riding” on or destroying strategies and gaining advantage (security)</td>
</tr>
<tr>
<td>10</td>
<td>IS are at the nexus of all disciplinary fields but are not part of these disciplines (inter-disciplinary).</td>
</tr>
</tbody>
</table>

Proposal of these principles set the scene for a dialogue within the IS discipline amongst academics and practitioners regarding their relevance to IS identity, and their further development for the interpretation of our BoK. The construction of a narrative of IS identity, using these principles as a lens of analysis (of key IS papers), will then be conducted as a means of understanding “who are we”?

REFERENCES


Galliers, R. D. (2003) “Change as Crisis or Growth? Toward a Trans-disciplinary View of Information Systems as a Field of Study: A Response to Benbasat and Zmud's Call for Returning to the IT Artifact” Journal of the Association for ISs Vol. 4 No. 6, pp. 337-351/November


GUI GENERATION BASED ON USER INTERFACE GUIDELINES

Kazuya Sugiuchi¹, Junko Shirogane², Hajime Iwata³ and Yoshiaki Fukazawa¹

¹Waseda University
²Tokyo Woman’s Christian University
³Kanagawa Institute of Technology

ABSTRACT

Although designing graphical user interfaces (GUIs) is a costly task in software development, GUIs realize highly usable software. User interface (UI) guidelines are published documents that describe how to design GUIs within a specific platform, and applying UI guidelines when developing GUIs provides consistency. To reduce the costs of designing and porting GUIs, we propose a method to automatically apply UI guidelines to GUIs. Our method analyzes GUI source programs that have been or are being developed.

KEYWORDS

Graphical user interface, usability, user interface guidelines

1. INTRODUCTION

Typically, software products are designed to run on multiple platforms. For example, Google Chrome works on Microsoft Windows and Mac OS X. However, the platforms have design and control differences in their graphical user interface (GUI). By porting software products between platforms, their usability can be improved.

Usability is important in software development because it improves the ease of operating a software product. However, it is difficult to make GUIs usable for all users. Regardless of the software’s functionality, a low usability will reduce its effectiveness. Although there are several definitions for usability, the two most common are the ISO 9241-11 and the definition by Jakob Nielsen. As demonstrated above, defining usability is difficult, but developing software with a high usability is even more difficult.

Each platform has published its own user interface (UI) guidelines. These documents describe the design rules for software GUIs. When these rules are applied, software with consistent operations and usability can be realized. However when developing and porting software, developers must manually implement and modify source programs. Because UI guidelines contain numerous rules, it is difficult for developers to recognize where and how to apply the rules, resulting in mistakes and missing implementation.

Our research focuses on developing a method to generate GUIs based on UI guidelines by analyzing the GUI source programs that have been or are being developed. Our method is an approach to generate GUIs adapted to a specific platform. For GUIs already developed, our method aids in porting, but for GUIs under development, our method helps realize GUIs that apply the UI guidelines. With our method, it is unnecessary to verify whether the GUIs adhere to the numerous rules within the UI guidelines.

2. USER INTERFACE GUIDELINES

UI guidelines are documents describing the rules for software GUI designs and operations. Applying these guidelines allows software developers and UI designers to realize software consistency within a platform. Many UI guidelines have been published, e.g., Microsoft Windows User Experience Interaction Guidelines, Mac OS X Human Interface Guidelines, and GNOME Human Interface Guidelines.
There are several benefits of adapting UI guidelines to GUIs. Applying UI guidelines allows consistent
operations and designs of GUIs to be realized, which improves operational consistency between software
products within a platform. A user can apply his or her experience of one software product to other software
products without learning new operations, which increases operating efficiency. Additionally, software
manuals in simple terms benefit both users and developers. Users can use the software products without
reading the manual, while developers can decrease costs and burdens of preparing manuals because the
operations are similar to other software products. Hence, using UI guidelines to make layout decisions
simultaneously improves usability and reduces development costs.

3. FEATURES OF OUR METHOD

In our research, we aim to reduce costs when applying UI guidelines by automatically generating GUIs based
on UI guidelines. The features of our method are described below.

In software development, time and cost are necessary to design GUIs. In particular, usability testing
requires iterative modifications. In these tests, users actually use the GUIs to provide feedback to developers.
Through feedback, the developers modify the GUIs. This iterative process improves the usability of GUIs.

Because UI guidelines contain many items, it is difficult to apply all items manually. Our method aims to
generate GUI source programs by applying UI guidelines. Our method analyzes GUI source programs and
extracts GUI data, which makes it easier to develop GUIs with a high usability and reduces the burdens of
developing and modifying GUIs. Reducing the costs of the GUI development process decreases the overall
cost of software development.

Currently, many software products are designed for multiple platforms. Applying UI guidelines provides
consistency to GUIs. However, the design strategies of GUIs often differ between platforms. For a software
product to operate on different platforms, developers must modify the GUI source programs.

Our approach generates GUI source programs by analyzing the GUI source programs that have been or
are being developed. This manner, the software program can be ported to other platforms.

4. PROPOSED APPROACH

Our approach generates GUI source programs by analyzing the implemented GUIs and applying UI
guidelines. In our method, the developers initially select the GUI source programs and UI guidelines of a
specific platform. Then our system analyzes the selected GUI source program and identifies which items in
the UI guidelines can be applied to each widget and window in the GUIs. Finally our system applies the rules
of the identified items in the UI guidelines to generate source programs of GUIs. Currently, our method is
limited to GUIs written using Java. Figure 1 shows structural drawings of our system.

4.1 Selecting Source Programs and UI Guidelines

The first step in our approach is for the developers to select the source programs and the UI guidelines of the
target platforms, such as the Windows User Experience Interaction Guidelines or the Mac OS X Human
Interface Guidelines.

4.2 Analyzing GUI Data

To analyze the selected GUI source programs in 4.1, our approach uses a parser made by JavaCC (Java
Compiler Compiler). This parser extracts the following GUI data: types of widgets, variable names of
widgets, methods used by widgets, arguments of the methods, and code locations of the widgets. Figure 2
and Table 1 show examples of the analysis.
4.3 Identifying items in UI Guidelines to be applied to GUI Elements

There are numerous items in UI guidelines, and each item has its own rules. Although the items and rules that can be applied to the extracted widgets in 4.2 must be identified, not all the items and rules can be applied automatically. Thus, our method classifies items and rules into three categories: automatic modification, additional input requirements, and confirmation. “Automatic modification” describes items that our system can automatically apply to the target GUIs. “Additional input requirements” refers to items that developers must input additional information, such as a widget description, before our system can apply them to the target GUIs. “Confirmation” indicates that our system only generated instruction for an item, and confirmation by the developers is necessary.

4.3.1 Automatic Modification

For items and rules identified as automatic modification, our system generates source programs of GUIs by applying these items and rules. An example of such an item is the menu shortcut keys. When analyzing GUIs, there are two ways of applying the items. Frequently, the assigned label names for menu items with shortcut keys are used. Shortcut keys are determined based on their correspondences between label names and specific keys (Table 2). If label names are frequently used, then the key codes are specified based on the key code of the assigned shortcut keys to the menu items from Table 2. Typically for Windows, a shortcut key is a combination of the CTRL key and another key, whereas for Mac OS X, the shortcut key is a combination of the command key and another key. When the corresponding key codes are identified from Table 2, they are applied automatically. If the corresponding key codes are not found, the CTRL key code in Windows is replaced with the command key code in Mac and vice versa.

4.3.2 Additional Input Requirements

When our system identifies items and rules as those requiring additional input, our system requires developers to input more information before the source program is generated. An example is the window title. According to the UI guidelines, each window should have a title. In the case where a window lacks a title, our system cannot automatically assign one. Thus, our system flags the item to indicate that additional input from the developer is necessary.

4.3.3 Confirmation

When our system identifies items and rules as confirmations, developers must confirm or modify source programs because our program cannot automatically apply the UI guidelines. An example is a check box. According to UI guidelines, the maximum number of check boxes is ten for a selection group. Our system can detect how many check boxes are in a group, but it cannot modify the number automatically if it exceeds the maximum. Hence, our system generates a confirmation message to the developers to reduce the number of check boxes.
Table 1. Example of analyzed GUI data

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Type</th>
<th>Arguments</th>
<th>Location of code</th>
</tr>
</thead>
<tbody>
<tr>
<td>fileMenu</td>
<td>Menu</td>
<td>Edit</td>
<td>20</td>
</tr>
<tr>
<td>fileMenu</td>
<td>Access key</td>
<td>E</td>
<td>21</td>
</tr>
<tr>
<td>undoMenuItem</td>
<td>Menu item</td>
<td>Undo</td>
<td>24</td>
</tr>
<tr>
<td>undoMenuItem</td>
<td>Access key</td>
<td>U</td>
<td>25</td>
</tr>
<tr>
<td>undoMenuItem</td>
<td>Shortcut key</td>
<td>Ctrl + Z</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 2. Examples of shortcut keys

<table>
<thead>
<tr>
<th>Label name</th>
<th>Windows</th>
<th>Mac OS X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Save</td>
<td>Ctrl + S</td>
<td>command + S</td>
</tr>
<tr>
<td>Undo</td>
<td>Ctrl + Z</td>
<td>command + Z</td>
</tr>
<tr>
<td>Redo</td>
<td>Ctrl + Y</td>
<td>command + shift + Z</td>
</tr>
<tr>
<td>Help</td>
<td>F1</td>
<td>command + ?</td>
</tr>
</tbody>
</table>

4.4 Generating Source Programs

After identifying the items in the UI guidelines to be applied to the GUI elements as in 4.3, source programs of GUIs that apply the UI guidelines are generated. The applicable parts of the UI guidelines inputted in 4.1 are identified, and the generated codes are inserted. Figure 3 shows the result of Figure 2 that applied Mac OS X guidelines.

5. EVALUATION

To evaluate our method, we ported some Windows software products (A, B, C, D) into Mac OS X software products. In this evaluation, we implemented GUIs similar to the software products, and our system analyzed the implemented GUIs. For Software E, we applied Windows UI guidelines to a software product that we have made for this evaluation. Table 3 shows the results.

Table 3. Results of the proposed approach

<table>
<thead>
<tr>
<th>Software</th>
<th>Type of the software</th>
<th>Type of window</th>
<th>Widgets</th>
<th>Automatically modified</th>
<th>Additional input</th>
<th>Confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Web browser</td>
<td>Main window</td>
<td>115</td>
<td>30</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Text editor</td>
<td>Main window</td>
<td>122</td>
<td>48</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>Web browser</td>
<td>Option window</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>Text editor</td>
<td>Option window</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>Text editor</td>
<td>Main window</td>
<td>18</td>
<td>30</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

“Widgets” indicates how many widgets were detected in the GUIs. “Automatically modified” indicates the number of UI guideline items that were automatically modified to the GUIs. “Additional input” indicates how many additional items were required, and “Confirmation” indicates the number of items that could not be modified automatically.

For Software A, only shortcut keys were automatically modified. A confirmation occurred due to the submenus. Mac OS X UI guidelines indicate that only one level of submenus should be used, but Software A’s GUI contained two levels of submenus.

The results for Software B are similar to software A; only shortcut keys were automatically applied.

For Software C and D, Windows and Mac OS X have opposite UI guidelines for the “OK” and “Cancel” buttons. These UI guidelines items were automatically applied.

Additional input items were not required for these software products, most likely because the GUIs of these products are well designed. Additional inputs are generally required when a design lacks information.
For Software E, shortcut keys and access keys were automatically modified. And an additional input was required due to the lack of window title.

In this evaluation, we implemented GUIs similar to those in the existing software product. Our evaluation results indicate that our method appropriately applies UI guidelines to GUIs. However, many manners can be used to GUI source programs. Hence, our system must be able to analyze source programs with various writing manners.

6. RELATED WORK

Sajedi et al. discussed how UI guideline items improve usability, and suggested changes to improve the UI guidelines. Their research concluded that the effect of UI guidelines on important UI factors varies. For example, color is a powerful tool but should be used carefully because some people have a form of color blindness. Unlike our research, their work focused on UI guidelines items and not on the application of UI guidelines.

Janeiro et al. investigated the enhancement of UI design patterns with design rationale structures. UI design patterns are well-documented patterns that include solutions for common problems, and following these patterns can improve usability. However, patterns are documented in natural languages, which makes a systematic approach difficult. Janeiro et al.’s approach combined natural languages with rationale structures, helping developers search and reuse design patterns. Compared to our research, they focused on design patterns and UI guidelines with more design descriptions.

7. CONCLUSION

We proposed an approach to apply UI guidelines to GUIs automatically by analyzing the GUI source programs that have been or are being developed. Our method may reduce the costs of developing GUIs with a high usability. The evaluation demonstrated that our method could appropriately apply UI guidelines. However, not all UI guidelines are applied automatically; some items must be manually revised after generating the source programs.

Currently, our approach includes only a few UI guideline items. In the future, we intend to increase the number of UI guidelines items, improve our software, and increase the application platforms to portable terminals such as smartphones and tablet PCs.

REFERENCES

Book

Conference paper or contributed volume

World Wide Web page
APPLYING LESSONS LEARNED AS AN IMPROVED METHODOLOGY FOR SOFTWARE PROJECT MANAGEMENT

Anderson de Souza Góes, Marco Hisatomi, Bruno Omena Mesquita and Rodolfo Miranda de Barros
Universidade Estadual de Londrina - Rodovia Celso Garcia Cid, Pr 445, km 380 - Londrina Paraná

ABSTRACT
Considering the causes of failures in project management, this paper aims to apply lessons learned techniques seeking to provide the efficiency and effectiveness of the results in the software development and management. For this, techniques have been developed during the project based on Knowledge Management, Knowledge Engineering and Maturity Models. Still in this article will be specified the applicability of these fundamentals in managing software projects, taking into account the lack of management problems in the knowledge management process focusing on the difficulties encountered by companies in the dissemination of knowledge.

KEYWORDS
Lessons Learned, Project Management, Knowledge Management, Organizational Culture.

1. INTRODUCTION
Lessons Learned (LL) is considered the content domain of the people of an organization and itself, where this knowledge was acquired by one's own experience of the project team. A LL may have influence outside the organization due to the participation of other persons or for research in other documents. Goes and Barros (2012) define LL as a resource of information storage in the own organization.

One of the factors that hinder the creation of an organized structure for storing knowledge in the organization is the diversity of information sources. With this in mind, this paper proposes using Lessons Learned to optimize these difficulties. The sources of information may be internal or external to the organization, in any of these is the need for their classification. They don’t always contribute or form part of the scope of the organization, which requires at least be related to company matters.

Although project management has a diverse and extensive list of techniques to accomplish their goals and achieve project success. There are specifics in knowledge management that can be supplemented to improve software development. For each activity performed by members of a project team may have one or more LL to be considered, increasing the level of success of this project.

To this end, this article has been divided as follows: Section 2 is a literature review related work with the presentation of a comparison table. In section 3 are the results of the proposed features. And finally in section 4 is the conclusion of the application of this study and future works.

2. LITERATURE REVIEW
In the process of literature review were done numerous studies on the two main aspects of this work, Project Management and Lessons Learned for built the principal process of literature review, that is a review a study was conducted on similar works in order to structure and qualify the proposal of this work.
2.1 Related Work

In the area of information technology much research has been conducted focusing on lessons learned. Among them we can mention the architectural model (Andrade et al., 2013), which proposes the use of a model to manage the lessons learned in the testing phase. In it is defined a structure to support the use of lessons learned during this phase. Along with this structure they proposed a set of procedures to manage it through a tool for this purpose.

Rogers et al., (2007) prepared a guide containing major errors in the process of lessons learned. This topic was much discussed in the NASA (National Aeronautics and Space Administration) especially after the incident with the space shuttle Columbia. In this guide, the authors focus on the three main stages of the process, they are a collection of lessons, managing and implementing them in future projects.

In the work of Mendoza and Johnson (2006) the lessons learned process is used to develop and maintain an organizational memory in a NASA research center. This center develops high-risk systems. Through the use of interviews, decomposition and reintegration of tacit knowledge to explicit information gathering and dissemination using them managed to establish a process and obtained good results after its implementation at the center.

The lessons learned can also be used within a larger context of knowledge management, as described by Goes and Barros (2012). In their paper, the authors describe a corporate portal composed of eight modules that manage knowledge within a software factory. The focus of the work was on lessons learned module, where a model was developed to manage the lessons within the portal, along with a tool that implements.

Also as part of this approach in the literature on related work was done to build a comparative table. From the main research methodologies in project management, focused on software development, it was possible to raise the features in the use of LL Based on this research was elaborated comparative table (Table I) that cites how each methodology contributes to the success of a project. The next subsection contains a brief description of the issues that motivated the creation of the comparative table.

2.1.1 Description of the Comparative Table

When it comes to building a knowledge base, Basili (1996) the CEBASE (Center for Empirically Based Software Engineering) defines what is necessary to define and improve methods of construction of LL Employing resources and proper techniques in organizations can achieve concrete results and positive projects in software development.

The Organizational Culture has essential influence on the process of creation and use of information management and knowledge Nonaka (2000). The acquisition of knowledge is an evolutionary process that people realize the difference between practice and theory. In the organization, this perception is perceived from the explicitness of information and knowledge.

Among the tasks assigned positions in the workforce, in an organization, it is important to have defined the bidding activity of LL. The integral of a software project goes through unique experiences throughout the project, this experience can become a LL for organization. Widely described in PMI (2008), the use of LL is ranked as one of the organizational process assets.

The interrelated elements in the knowledge construction can be used in various ways by low cost. Having a knowledge explicit McLean (1999) can relate one to the other, have the complement of one to the other. It is common knowledge that one use knowledge information from another, thereby creating a dependency between them.

But for every situation in different projects this LA must be validated for their efficiency or effectiveness, in view of the restrictions and requirements or this project. For this it is necessary that a procedure be established and followed to be applied to each scenario. Thus, following criteria according to the project as restrictions on scope, quality and requirements, as shown in Table 1.

Therefore according to Table 1, the effectiveness of using LL is related to communication. Knowledge workers have a need to express their feelings. Thus efficient communication can positively influence the use of a facility in LL. Besides the use of tools to seek an LL, it is extremely important that the person is motivated to use it.

Also according to Table 1 can recognize that such items addressed reflect the reality of companies that possess the knowledge as one of its organizational assets. And with the implementation of these proposals realize the benefit of using the technique of applying the acquired knowledge in future projects.
Table 1. Comparative of Methodologies and Technologies with Developed Proposals

<table>
<thead>
<tr>
<th>Criteria</th>
<th>SCRUM</th>
<th>FFP</th>
<th>CDIT</th>
<th>PHMOK</th>
<th>ITL</th>
<th>CMII</th>
<th>MWMP</th>
<th>Developed Proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Impact on the Organization</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Overall view of the project (Time, project scope, and review of the project)</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
<td>Not Specified</td>
</tr>
<tr>
<td>3. ADVANTAGES OF LESSONS LEARNED IN PROJECT MANAGEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on the issues raised and described in Table I and in the proposal, a study was conducted about the main advantages that its use can provide in the application of lessons learned in project management. To this end, according to literature, based primarily on Goes and Barros (2012), Roe (2011), Andrade (2013), Horita et al (2012) and Rautenberg (2011) can be detached three major advantages in their use, these being listed in subsections 4.1, 4.2 and 4.3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Organizational Culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At instant that people are discussing about a solution of a possible LL the understanding becomes fast. But as time goes on, and the longer the time go back to discuss the LL the understanding becomes slower. By providing for the use of the lesson, the organization, as ongoing activity in higher frequency, the results will become more evident and effective.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Ease Search by Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ease in retrieving a LL is related to the form and method in which it was stored. Multiple entries can be retrieved for the same search term, so that the search becomes efficient and complete, returning a complete picture with all matters pertaining to the term in question.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

304
first, we present additional information that help to decide by this operation. In the second, are listed options
that add extra procedures or values for a particular operation.

In project management, to realize that there is a delay in schedule, the tool could alternatives to resolve
this situation, based on LL. In the same way, the tools of project management could offer these features for
more efficient use of projects in previous LL.

3.3 Configuration Management

The history of an LL, properly arranged in a configuration management, to become effective decision-
making. When comparing a modification projects conducted in the past, the manager can analyze the
effectiveness of LA for that situation. And, compared to a situation when necessary, can also decide whether
the same lesson is applied or not.

Consequently, it creates a comparison between a version with an item registered the previous projects.
For example, when doing an analysis and generate an artifact (use case), may have a relationship with a LL
which in turn could be sure that when we prepared this artifact was generated with the "n" version of LL,
thus realizing the full control of the use of the lessons in the projects.

4. RESULTS

Through the process of evaluation of the proposal, for people involved in software development such as
project managers, it was possible to tabulate a satisfactory result. This process was implemented in three
phases, with the first presentation, then the application of the assessment and evaluation of the final
tabulation.

As proposed by Rautenberg (2011), the methodology for collecting the results were submitted to three
groups of people: specialists, non-specialists and project managers. Those who know and study deep
knowledge management are classified as experts. Getting as non-experts, the other participants of the
software factory GAIA. And finally, those who know and practice the management of software development
projects.

For the evaluation, questions were presented in which participants could analyze the applicability of the
proposals of this article. Each question has with goal verify whether the benefits proposed for LL would be
effective in the management when applied in real projects.

Encouraged by questionnaire and by the proposals, the evaluation participants could respond with
alternatives ranging from 1 to 5. Where, 1 represented "no advantage" and 5 "guaranteed benefit." From these
responses, the tabulation was performed to find an average of 4.44, which assures us that there is effective
use of this product proposals in 88.8%, as shown in Table 2.

<table>
<thead>
<tr>
<th>People Surveyed</th>
<th>Score</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialists</td>
<td>4</td>
<td>4,5</td>
</tr>
<tr>
<td>Non-specialists</td>
<td>4</td>
<td>4,33</td>
</tr>
<tr>
<td>Project Managers</td>
<td>5</td>
<td>4,5</td>
</tr>
<tr>
<td>Total Average</td>
<td>4,44</td>
<td></td>
</tr>
</tbody>
</table>

At significant result, presented in this sampling specialists, non-specialists and project managers, we
conclude that the proposals can be applied to make more effective project management. Looking at Table 2,
verified that the difference between specialists and non-specialists was only 0.17 (or 3.4%) and there was a
tie between specialists and project managers. Thus it is concluded that the use of the proposals apply to the
three groups.
5. CONCLUSION

Using Lessons Learned integrates and works as a tool to aid in Knowledge Management in Organization, this management brings a gain that is directly linked to Project Management. Allowing employees access to previous experiences in organization contributes to the improvement of results obtained in future projects.

This management Horita and Barros (2012) reflects the evolution of the organization where the desire to correct past missteps and perpetuation of actions that reflected good results represents an often routine of process improvement. The proposals contained in this work, which were the result of a literature search of best practice lessons learned in conjunction with the main requirements encountered in project management, proved invaluable. This fact can be seen in the results of the questionnaire, where experts and non-experts evaluated whether the proposals would be effective if they were implemented.

In future work we intend to evaluate the implementation of the proposals within some organizations and analyze the results. And with that establish a framework for the deployment and management of lessons learned oriented software development.

REFERENCES


CONTRIBUTION OF KNOWLEDGE MANAGEMENT SYSTEMS TO TRANSACTIVE MEMORY SYSTEMS DEVELOPMENT

Pascale Nassar Hatem
Université Paris Dauphine - B1801 Beit El Chaar, Lebanon

ABSTRACT
“Transactive Memory, or Who knows what is a shared system for encoding, storing, and retrieving information” (Wegner et al., 1985, Wegner, 1995). Alavi and Leidner confirmed that Information Technology facilitates knowledge sharing among team members (Alavi and Leidner, 2001). Little to our knowledge though has been done to describe practically how knowledge management systems (KMS) can improve knowledge sharing and develop Transactive Memory Systems (TMS) in organization teams (Alavi and Tiwana, 2002, Sue Young et al., 2010). This empirical case study introduces a model of KMS contribution to the development of teams’ TMS in a fast moving and changing organization (Brandon and Hollingshead, 2004, Lewis, 2004). This paper will give practical examples on how the KMS tools can facilitate the communication between the users looking for knowledge and the owners of this knowledge.

This research is limited to one case study, but can serve as a reference for professionals in the process of implementing a KMS, and for researchers studying the contribution of Information Systems (IS) and KMS to knowledge management (KM) and TMS building. The topic was proposed as an opportunity for future research (Sue Young et al., 2010).

KEYWORDS
Knowledge management systems, Transactive memory systems.

1. INTRODUCTION
KMS is a rather recent type of Information Systems (IS) developed to help users in creating, storing, sharing, transferring and implementing knowledge in organizations (Alavi and Leidner, 2001). This research aims at giving a practical example from the field on how a KMS can contribute not only to improve knowledge exchange, but also to develop the TMS of teams in a changing and competitive environment (Rindova and Kotha, 2001). The paper introduces a model of KMS with functionalities that help expand the TMS within a multinational organization.

The empirical section describes the evolution of knowledge exchange and communication within teams and cross teams, and its contribution to TMS building. We will highlight the KMS most used functionalities related to TMS building.

The paper covers first the theoretical part, and then discusses the methodology applied in the research; the empirical research follows with the contribution of the study to the academic and professional literature, its limitation and the proposition for future research.

2. THEORETICAL ASPECTS
The TMS theory is the motor of this research which objective is to give an example from the field on how an information system helped highlighting “who knows what”, via simple functions and processes, in a multinational company going through changes.

This case study is a longitudinal observation of the implementation of knowledge management and knowledge management systems between 2008 and 2012 in a growing multinational IT company. After 2007, reorganization started and is still ongoing to-date, to adapt to continuous changes in a field that has
been strongly impacted by the economic crisis. Knowing whom to contact for functional or operational questions had become a struggle within cross and multi-functional functional teams in over 10 sites worldwide. In the field of KM and KMS, it was important to develop functions that enable an easy communication between the users searching for knowledge, and the knowledge owners. The tools were implemented in 2008. Our interest in a research study started mid-2009 and this paper is part of our study on the contribution of KMS to KM (Alavi and Leidner, 2001).

3. METHODOLOGY

The importance of the Knowledge Management is growing, and organizations are more aware of the importance of knowledge exchange as a key factor of success and as a competitive advantage (Feeny, 1990).

This study is the observation of the development and implementation of KMS with a post-positivist perspective since April 2008. It will focus on the role and contribution of few functions in the KMS related to knowledge sharing and integration, and to TMS building.

A few samples on the communication processes, and on the coordination between teams and between users will be presented as an evidence of the contribution of an IS to TMS building (Nonaka et al., 1994). A content analysis will highlight the most raised communication topics.

A questionnaire on the users’ feedback of the implemented KMS will be deployed in January 2013 to more than one thousand users. The results of the questionnaire will give a better understanding of the users view on the communication tools and the TMS facilitating functions embedded in the KMS.

Depending on the results, semi-directional interviews might be conducted with the leaders of the most contributing and representative teams, in order to have additional information and to build on the current developments, with the objective of improve improving if necessary or generating more awareness communication around these specific functions, therefore making them more popular.

4. EMPIRICAL RESEARCH

This research is a case study describing the contribution of the KMS of an organization to its TMS building. The research objective is to highlight a model of KMS with features which facilitate the communication with the experts, the people Who Know (Oshri et al., 2007). The shared knowledge is diversified and categorized per specialisation or per organization divisions. It covers the description of the company’s products to be shared internally and with the company’s external community; it also applies to internal processes and best practices, lessons learnt, and to more general knowledge that would improve the skills and performance of users within each team and cross teams.

4.1 KMS Functions Related to TMS Building

The KMS has evolved and grown to ensure a multitude of functions and activities. This study will highlight some functions which, in our opinion, help improve knowledge sharing and TMS building.

4.1.1 Centralization: KMS Access via the Intranet

Knowledge in the considered organization used to be distributed over different tools and environments. Information was not easily accessible, and sometimes not even shared globally within the same functional teams which are dispersed over different geographical sites. The centralization of knowledge is one of the priorities in order to allow equal access and learning opportunities to all; the easier the learning, the faster the TMS building.

4.1.2 Contact the Experts

In this paper, the term “document” will represent the knowledge unit. The ownership of a document grants its owner teams the responsibility over their shared knowledge, and enables them to follow up and update the shared knowledge, therefore ensuring the availability of up-to-date and high quality content information.
The administrator of the owner team grants each member in his team a profile that reflects the level of his expertise, seniority and contribution to the team’s knowledge. More specific expertise can also be added by the team manager or by the users themselves in a dedicated expertise field. The Expertise can be shared by users from different teams like a tag; a search by an expertise field enables learning about who knows what in this field, and can create cross team collaboration on knowledge creation and maintenance.

A link available on each document header enables the reader to contact by mail the document owner team and the experts. The user does not need to ask around him whom to contact or look for the info in other organization systems. The mail is automatically populated with the relevant experts in the recipient field, and enables adding manually other people in the thread. Linking closely the experts to the shared knowledge facilitates TMS building (Wegner et al., 1985, Moreland and Myaskovsky, 2000).

Experts in a field could be spread over different teams and divisions because of internal rotation or past experience. They have hence the opportunity to declare their expertise, therefore creating a community of expertise and facilitating the development of the organization TMS.

The exchanged mails are available via a link in the document itself; the informal exchange gives the reader more tacit knowledge than the document sometimes. The learning from the questions asked by others helps reduce the users’ questions, and also brings then awareness on new questions.

Table 1. Sample comment types from Contact the Experts mails

<table>
<thead>
<tr>
<th>Comment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing details</td>
</tr>
<tr>
<td>Request description improvement</td>
</tr>
<tr>
<td>Highlight errors</td>
</tr>
<tr>
<td>Feedback from the application of the described process</td>
</tr>
<tr>
<td>Contribution from users’ experience on the field</td>
</tr>
</tbody>
</table>

4.1.3 Rating Documents

Document rating is enabled on all documents which are shared on the intranet. A comment field is available where users provide additional details on the rating, which represent a feedback addressed to the document owners. This helps the owners’ team in improving the content and in maintaining a high quality an useful knowledge.

When a document is rated, an automatic mail is sent to the experts in the owner teams. They can answer the “rater” directly, and they can bring adjustment to the document contents if appropriate. A communication is hence established between the reader-rater and the experts. The reader can rate a document several times, and an indicator will display how the rating has evolved.

All rating mails are accessible to all on the document header; they provide the reader with an evaluation of the quality of the document, before reading it. These exchanges are viewed in the format of a discussion forum.

Teams who started rating documents and receiving rating of their documents typically show much interest in the functionality. By reviewing few rating samples, we noticed that some experts are doing their best to maintain very coherent and accurate documents; they are often warmly thanked by the readers.

Table 2 gives few illustrative discussions:

Table 2. KMS - Sample discussions in the rating mails exchanged

<table>
<thead>
<tr>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could you kindly indicate us how this document could be improved?</td>
</tr>
<tr>
<td>The documentation barely mentions those products. Second thing was that this documentation seems to exist only for the old version. Are all those concepts still applicable for the new one?</td>
</tr>
<tr>
<td>We updated the documentation to clarify this; let us know if you recommend other improvements.</td>
</tr>
<tr>
<td>Thank you for rating this article. We would be happy to get your constructive suggestions or what areas could be improved?</td>
</tr>
<tr>
<td>Could you please give us a little more insight that explains this very poor rating you have given? We are working very hard on our documentation and we did not really get the reason of this. We thought the documentation was quite explicit for a reference guide</td>
</tr>
</tbody>
</table>
4.2 Preliminary Results

Freshly graduated and experienced newcomers are always pleasantly surprised to have access to all the shared knowledge and to learn about experts when consulting the documents on the KMS. Feedback like “I could not imagine finding all this information available to all; it is so helpful” is very frequently heard.

As a good indicator, the KMS is intensively used (Kun Chang Lee, 2004), as shown in Table 3.

<table>
<thead>
<tr>
<th>Audit and Stats</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of specialized Knowledge Bases (KB)</td>
<td>123</td>
</tr>
<tr>
<td>Overall number of valid documents</td>
<td>&gt;15,000</td>
</tr>
<tr>
<td>Consulted articles since beginning of 2012</td>
<td>486,231</td>
</tr>
</tbody>
</table>

The Rating comments and the feedback in the Contact the experts mainly raise the issue of missing explanation in the documents; it expresses the user’s satisfaction or his feedback after the application on the field of the shared knowledge.

More feedback on the users’ appreciation of both functionalities will be collected from the questionnaire that will be deployed during the first months of 2013.

5. CONCLUSION AND CONTRIBUTION

A research has shown that information systems contribute to the development of teams’ TMS (Sue Young et al., 2010). This paper aims to bring an answer to Sue Young call for empirical studies describing how information systems can practically contribute to knowledge sharing and to teams’ TMS building. The empirical study can be used as a reference both by scholars and practitioners.

The users’ feedback on the studied KMS, the observations carried out over many years in the field, and the started content analysis of the comments in the Rating and the Contact the experts are positive indicators that KMS does help building teams’ TMS. The survey results will bring more tangible answers to our perception.

Final results from the evaluation of the KMS by its end-users will determine whether the introduced tools in the KMS are successful one, and if it is worth being implemented to other KMS.

REFERENCES


COMMUNICATION MODEL FOR IMPROVING KNOWLEDGE CAPTURE IN COTS-BASED SYSTEMS

Anat Segal-Raviv1, Meira Levy2 and Irit Hader1
1Department of Information Systems, University of Haifa, Mount Carmel, Haifa, Israel
2Department of Industrial Engineering and Management, Shenkar College of Engineering and Design, Ramat-Gan, Israel

ABSTRACT
Software maintenance constitutes a significant part of software development, which sometimes becomes the lion’s share of the project workload. Being a highly knowledge-intensive process, software maintenance can greatly benefit from knowledge management. Many software projects integrate commercial off-the-shelf (COTS) systems components in their projects and face knowledge-related challenges that are specific to such systems, like communication with the software vendor, understanding the ready-made components and more. While many methods have been suggested to improve knowledge management for software maintenance, little has been done in the field of COTS systems maintenance. In this paper we explore the COTS systems maintenance process from a knowledge-related perspective. To this end, we conducted an empirical study within a software project that is responsible for COTS system integration and maintenance. Following the findings of this study, we propose a new model for improving knowledge capture by examining the communication between COTS system players and stakeholders and utilizing knowledge management tools.

KEYWORDS
COTS, knowledge management, software maintenance, model

1. INTRODUCTION
Software maintenance is composed of a variety of knowledge-intensive tasks. Comprehension of an existing software constitutes about half of the maintenance effort (Pigoski, 1996; Pfleeger, 2001). Other tasks include: allocating data sources, understanding the software domain, knowing organizational written and unwritten rules, knowing who-knows-what effort (Pigoski, 1996; Pfleeger, 2001); enhancing features, repairing defects, code modification during system migration, version management and customer support (Sarkar et al, 2008), writing code, submitting a change, triaging bugs, reproducing a failure, understanding execution behavior and reasoning about design (Ko et al, 2007). Therefore, much of the maintenance quality and duration depends on the maintenance team’s ability to find and understand task-related knowledge.

Using ready-made COTS components brings benefits, such as increased quality and reduced development time, along with challenges such as complicated composition and dependency on the software vendor (Li et al, 2009). Maintenance costs of COTS systems were found equal to or exceeding developing custom software costs (Reifer et al, 2004). This finding leads to the following question: Can this effort be reduced without harming quality by improved knowledge management? A previous study showed that the success of a COTS systems projects is related to management of implicit and explicit knowledge about the off-the-shelf components (Li et al, 2009). It is thus reasonable to assume that companies would benefit from capturing knowledge about the components themselves, such as basic functionality and side effects, along with knowledge about the stakeholders, such as client preferences and contact persons.

Software developers today utilize social technologies to coordinate with one another, to communicate with and learn from users, to become informed about new technologies, and to create informal documentation (Treude, 2007). Common social media features are being utilized to support software engineering processes. Wikies, for example, are being used to support defect tracking, documentations, requirements tracking and test case management (Begal et al, 2010). We believe that customizing social
media tools to specific knowledge domain, such as COTS system maintenance, can minimize knowledge gaps in that context and result in more stable software solution.

This study aims at understanding the knowledge gaps that occur during COTS systems maintenance and, more specifically, during defect handling. It follows the suggestion of previous study to take a wider social perspective into account when investigating the software development process (Brennan, 2008). We propose a conceptual model, which relies on utilizing social media tools and technologies for bridging these gaps.

2. THE EMPIRICAL STUDY

2.1 Methodology and Settings

The empirical study was conducted within a software team which is a part of the division of information systems and communication, Israel Electric Company, and is occupied exclusively with maintenance, integration and customization of a specific COTS system that is a package of numerous applications. The system contains ready-made applications that have to be customized to the organization’s specific business needs. It contains administration tools, such as authorization management, and applications for end users, such as workflow viewer and development infrastructure that enable system extensions. Regularly the team is occupied mainly with system maintenance, system administration and development of new customized programs, which are based on the system API. The system was first implemented in the organization over 15 years ago and is used to manage data and support internal engineering processes. The first author is a participating researcher who has been working as a software developer and analyst in this team for over 5 years. The study was conducted after the department manager expressed his interest in improving COTS integration and maintenance processes. The objective of the study was to identify knowledge gaps and particularly, knowledge-related flows that eventually caused software defects, by looking at software defect handling, and to suggest a knowledge-related solution.

The data was collected via semi-structured interviews, documentation collection and observations. The interviewees were of different roles across the organization, which participate or contribute to the process of defect identification and handling. Some of the questions emphasized issues of organizational culture and some emphasized professional issues. The interviewees were also asked about knowledge gaps in the process of defect handling, and of ways to improve current procedures. Collected documents included system defect reports, mail messages, system help and guidance documents, internal procedures, and meeting summaries.

The first author, being a participating researcher, conducted planned and unplanned observations during the work routine. Specifically, in this paper we focus on two major observations which took place during two events of system breakdown that went on for several days. The observations were not pre-planned but rather a spontaneous reaction to an emerging situation. There was one case where the participating researcher herself was in charge of handling a defect and one case where she only observed the situation. In both cases she observed and took notes during and after the defect had been fixed. The data was analyzed, taking into consideration the knowledge gaps that caused the defect. The researcher notified the team members that she was doing a research about defect handling and asked them to share information with her. In both observations, the causes for the breakdowns where investigated from a knowledge perspective.

The grounded theory methodology was used to analyze the collected data (Stauss and Corbin, 1994). The initial categories have emerged during the analysis of a generated defects report, containing records of defects from 2003 to 2012. The records of the defects report were iteratively analyzed until categories reached saturation. For each record we indicated which type of knowledge was missing and thus causing the defect, and who were the stakeholders involved. The transcribed data and other collected documents were
then divided into segments. For each segment it was decided whether it was related to defect handling. If so, a knowledge category was annotated. Segments that were not directly related to COTS knowledge were excluded from this study. Each category emerged from at least two different data sources, such as interviews and documentations.

Being a participating researcher presents some threats to validity and may cause research bias. In order to mitigate these threats and validate the findings we: collected rich data from diverse sources; included only findings that appeared in at least two data sources; and presented the findings to domain experts and received their feedback. Nevertheless, since this research is based on a single case study, the proposed solutions should be carefully considered before applying it to other cases.

2.2 Findings

For each record in the defects report we defined three knowledge aspects: the stakeholders involved in solving it, the type of defect and the knowledge sources that were used to resolve the defect.

The first aspect is revealing which stakeholders are involved in resolving the reported defect. We found five potential stakeholders for COTS knowledge: Maintenance team (programmers and project manager); End users; Customers; Vendor; External consultant. A customer is a representative of a group of end users and is responsible for requirement definition, testing, guidance and mediating between the end user group and the maintenance team. The stakeholders’ categories are the basis for our proposed model. In this model, we represent each group of stakeholders found as a social circle. However, the external consultants group was excluded from the model, since we found that the communication between them and the other circles is too sparse to justify their representation in the model.

The second aspect is type of defect. Here we found four categories:

- **Configuration defects** – defects that were related to customization of the software package and usage of administration tools, e.g. problems in system administration and configuration.
- **Usage defects** – problems that were reported as defects but were related to COTS system misusage, e.g. misunderstanding a system error message.
- **Requirement defects** – defects that originated from misunderstanding of COTS system limitations and methodology by the maintainers that result in a faulty requirement, e.g. a requirement to change a user interface feature that is part of the software package and is not designed to be configured.
- **Package defects** – defects in the software package itself that were later delivered to the vendor, e.g. insufficient support of foreign languages.

The third aspect, knowledge sources used for resolving software defects, yield four categories:

- **COTS system documentation** – requirement specifications, design documents, code documents etc. These are documents that are created during the system development lifecycle.
- **COTS system package documentation** – help documents, system API and administration guides.
- **External resources** – internet sites and blogs that specialize in this system.
- **COTS system specialists** – people who specialize in specific aspects of the system. Program developers, system analysts, external consultants and anyone that has in-depth knowledge about a specific issue of the COTS system.

2.3 COTS Communication Model

Based on the categories found, we propose a model for an improved COTS systems maintenance by improving knowledge management. The model describes the knowledge gaps that occur between the COTS system integration team and different stakeholders who cooperate with them during maintenance. The model refers to four social circles that relate to the COTS systems maintenance activities (see figure 1). Each circle represents a group of stakeholders that contribute or consume knowledge during maintenance. We suggest investigating what knowledge should be shared and communicated within each circle and in the interaction between different circles, in order to improve maintenance.
Nonaka and Teece (2001) argue that knowledge is constantly converted from tacit to explicit and back again as it passes through the organization. Tacit knowledge is knowledge that is difficult to express explicitly but is guiding the behavior of a human, while explicit knowledge can be represented in textual or symbolic form.

Our model focuses on capturing knowledge that is being created during communication between the different stakeholders, and can be transformed to explicit tangible knowledge, hence, refers to two of the four modes of knowledge conversion that were defined in Nonaka’s SECI model (Nonaka and Teece, 2001): 

- **Externalization** - articulating tacit knowledge into explicit knowledge; and
- **Combination** - converting explicit knowledge into more complex and systematic sets of explicit knowledge. Those two modes refer to creating explicit knowledge, which can be preserved as organizational knowledge assets over time. This is a general model aiming at guiding the organization in managing COTS-related knowledge.

Table 1 summarizes the communication model for COTS-related knowledge management. The first column details the knowledge types needed during the COTS system maintenance. The second column lists for each knowledge type the related social circles that participate in the knowledge flow. In the third column a knowledge problem example is given for each type. The forth column presents a possible knowledge management solution. Finally, the last column refers to the knowledge transformation according to Nonaka's SECI model (Nonaka and Teece, 2001).

<table>
<thead>
<tr>
<th>Knowledge Type</th>
<th>Social Circles</th>
<th>Knowledge Gap Found</th>
<th>Optional Knowledge Management Solution</th>
<th>SECI mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>COTS system configuration</td>
<td>1, 4</td>
<td>Some knowledge about COTS configuration is learned by individual team members and not shared.</td>
<td>Map who-knows-what regarding COTS issues inside the team. Allow searching for specialists according to this knowledge.</td>
<td>Externalization</td>
</tr>
<tr>
<td>COTS system configuration</td>
<td>1, 4</td>
<td>Navigation through a wide number of technical documentation is time consuming; so is finding documentation about new COTS part.</td>
<td>Utilize organizational search engine for searching the COTS-related internal documentation; Use the search engine to search in relevant external website that publish COTS knowledge (RSS)</td>
<td>Externalization</td>
</tr>
<tr>
<td>COTS system usage</td>
<td>1, 2, 3, 4</td>
<td>End users lack knowledge about operating the COTS system</td>
<td>Use knowledge management tools such as web forum, internal wiki and blogs to encourage COTS system knowledge sharing.</td>
<td>Externalization</td>
</tr>
<tr>
<td>Requirements of enhanced features</td>
<td>1, 2, 3, 4</td>
<td>Ignoring system limitation causes faulty requirements</td>
<td>Test new requirements against COTS system limitations during requirement definition phase.</td>
<td>Combination</td>
</tr>
<tr>
<td>COTS Package</td>
<td>1, 4</td>
<td>Defects that occur during COTS package implementation in the specific organizational environment</td>
<td>Manage vendor communication via a B2B system or a shared web site that enables text auditing and analysis. Manage risks based on the accumulated data.</td>
<td>Combination</td>
</tr>
</tbody>
</table>
3. CONCLUSION AND FUTURE WORK

Maintenance of software systems is a complex and challenging task in general. When it comes to COTS systems, additional challenges, such as communication with the COTS system vendor, need to be met. As the system evolves, the maintenance process becomes more complex and knowledge-intensive and the knowledge itself is being spread among more and more stakeholders and documents. Preserving knowledge assets during development and maintenance is highly important for the systems survivability and reliability. In order to preserve the unique COTS-related knowledge about the system, special attention should be given to knowledge-related processes and stakeholders, which are unique to the COTS system context.

In this paper we presented a work in progress, focusing on a case study in which we analyzed COTS system maintenance processes to identify the knowledge gaps in the process and their sources. Based on these findings, we proposed a COTS communication model for improving knowledge management and communication in COTS systems maintenance. The model focuses on communication with various stakeholders and other sources of information that create or consume COTS-related knowledge. Our findings are aligned with a previous study, recommending conducting more empirical studies in the field, and follow the suggestion to investigate the need to establish who-knows-what mechanism (Li et al, 2009).

Next we plan to build COTS-related taxonomy for the investigated case study, to implement it within an organizational search engine and to perform and experiment within the organization. During the experiment we will collect data about reported defects and data about search engine statistics, and try to find out if using the taxonomy as search filters assists in finding COTS-related data.

We expect that this implementation will yield further insights about what and to whom COTS-related knowledge is needed. We intend to further investigate the case study in order to elaborate and evaluate the proposed model. Future work will be required for generalization of the findings, and refinement and validation of the COTS communication model.

REFERENCES

Treu.de C., 2007, The Role of Social Media Artifacts in Collaborative Software Development, a dissertation submitted in partial fulfillment of the requirements for the Degree of doctor of philosophy in the Department of Computer Science, University of Siegen
SUPPORT FOR NOVICE SPECIALISTS IN REMOTE CONSULTATION

Hiroshi Yajima\(^1\), Kota Shimura\(^1\), Manabu Kurosawa\(^1\) and Jyun Sawamoto\(^2\)
\(^1\)Tokyo Denki University, 5 Senju Asahi-cho, Adachi-ku, Tokyo Japan
\(^2\)Iwate Prefectural University - Sugo, Takizawa, Takizawa-mura Iwate-Gun Iwate Ken Japan

ABSTRACT
In a world of turbulent change brought by increasingly widespread use of the Internet, the need for remote consultation is increasing. Various techniques have been proposed to support remote consultation. Along with the increasing need for remote consultation, the number of remote consultation specialists has also increased rapidly. However, it takes time to train novice specialists, so it is often necessary to use novice specialists. We propose a method for presenting the consultation with the response given by a novice specialist as if it were an automatic response to allowing the consultation to proceed smoothly without reducing the satisfaction of the consulter. The proposed method features creation of the psychological state in the consulter that he or she is conversing with a machine. We have validated this method by experiment and verified that it can improve the smoothness of the consultation without affecting satisfaction.

KEYWORDS
Remote consultation, automatic response, voice modification.

1. INTRODUCTION
Recently, there is now a great need for remote consultation in our turbulently changing world. Along with the increasing need for remote consultation, the number of remote consultants has also increased sharply.

That situation has been addressed by automation of the consultation work at the service end. We have developed technology for automatic consultation that, to a certain extent, does not have a fixed format. (Tanaka2002) For fixed-format consultation, automation has already advanced to the practical stage.

However, there are many limits to automation, so consultation that has more than a certain degree of variability in format requires a human specialist(Hiraguri1995, Sagayama2004). Because there are a variety of consultation, such as elder care, child education, many consultation needs not only specific knowledge but also humane consideration. It is therefore necessary to increase the number of specialists in services that provide remote consultation. However, it takes time to train specialists to an experienced level, so using near-novice specialists to meet the demand during that process is unavoidable. When that is done, there is an obvious problem of difference in consultation quality between the near-novice specialists and the experienced specialists(Katsuragi2006).

Call centers and other relatively simple remote consultation services have employed students and persons from temporary work agencies for short-term, intensive work as novice specialists(Katsuragi2010). However, dealing with excessive complaints in the work and the stress and illness caused by psychological pressure are reasons for employees quitting, and high turn-over of specialists is common(Tanaka2003). As a result, near-novice specialists who gain experience and knowledge in consultation work may leave the company for those reasons. Lost workers are replaced by hiring new, inexperienced specialists.

To address that problem, we propose a method for presenting the consultation with the response given by a novice specialist as if it were an automatic response and allowing the consultation to proceed smoothly, without reducing the satisfaction of the consulter. Our objective is to show that it can be verify for a counselor to achieve the purpose comfortable using the proposed method. The proposed method features creation of the psychological state in the consulter that he or she is conversing with a machine agent. Consulters think that they talk with machine, so they are generous about delay or mistakes in answer. We
have validated this method by experiment and verified that it can improve the smoothness of the consultation without affecting satisfaction.

2. PROBLEMS IN REMOTE CONSULTATION

2.1 Features of Consultation

The difference between consultation and ordinary communication is that consultation has a clear procedure from the beginning to the end (Tanaka2003). That procedure involves three phases (Fig. 1). Another feature of ordinary consultation is the difference in knowledge between the consulter and the consultant specialist (Tanaka2002).

2.2 Conventional Remote Dialog Systems

Some conventional remote dialog systems use video conferencing to supplement the consultation with non-language information (Matsuura2000, Kobayashi2002, Kobata1999, Inoue2006, Grayson2003). The main purpose is to allow the conversing parties to get facial expression information in real time in a manner similar to face-to-face interaction. Such systems are mainly used for ordinary remote dialog and teleconferencing; there are few examples of actual use in remote consultation. Also, experiments have confirmed that there is a strong feeling of nervousness when video is used for the first consultation with an specialist, especially for the consulter.

Although remote dialog systems for remote consultation (Kakei2001) have been developed before, their purposes were to solve the problem of too few specialists that possess complex expert knowledge and shortening of the overall consultation time (Tanaka2002). Accordingly, there was no particular consideration of the psychological state of the consulter, so it remained unclear whether or not the consultation process made the consulter nervous.

Consultation support has so far centered around automation of replies, but when the process involves highly unstructured interaction, automatic response functions are very likely to be difficult to implement. Also, the research that has been done on ordinary telephone consultation has been limited to the content and scope of the consultation, so it is not easily applied to remote consultation in general.

2.3 Conventional Remote Dialog Systems

The problem of novice specialists in remote consultation work arises from the gap in knowledge and the ability to present knowledge between veteran specialists and inexperienced specialists due to differences in experience. It has been suggested that the gap can be closed, but it is difficult to achieve in the short term.

Customer centers and other remote consultation services that deal with low-difficulty issues (product failures or other relatively simple consultations) provide the specialists with product manuals and other supplementary materials, so the flow of consultation is to some degree established. For that reason, the technical differences between specialists is small and there is no problem.

However, in highly unstructured consultation processes, novice specialists differ greatly from veteran specialists in knowledge and experience. When asked about something beyond one's own knowledge and experience, one must use a manual or collection of examples as supplementary knowledge to give the answer. However, that requires the consulter to wait and often causes the consulter to feel uneasy or distrust.
Up to now, a veteran specialist has taken over in such cases, but there are not enough experienced consultants to meet the need.

3. PROPOSED METHOD

3.1 Concept

Our basic approach to solving the problems described above is to conduct the remote consultation in a way that does not cause discomfort to the consulter by using an automatic response mode. Specifically, the voice of the novice specialist is modified and the reply mode are changed to an automatic response mode so that the consulter perceives the other party in the consultation as a machine. That is done to reduce the anxiety and distrust caused by the delay in the reply of the novice specialist. Also, consulter can ask questions with their own pace. That function is implemented by modifying the voice of the novice specialist and using a reply template to create a mechanical response style of output.

3.2 Conversion of Remote Consultation by the Proposed Method

We assume that human specialists and machine consultation agents have different psychological effects on the consulter. The consulter naturally considers the human specialist to have knowledge on the topic and expects to receive a satisfactory reply. If the consulter must wait some time and only receive a vague answer, for example, then the consulter will not feel satisfied and a strong feeling of distrust of the specialist regarding the consultation will arise.

When the consulter is dealing with a machine agent, however, the consulter probably will not expect a rapid reply no matter the hurry because of the difference in processing power of machines and humans. Thus, the consulter may not have excessive expectations even if they are actually dealing with a human specialist rather than a machine. For that reason, even though there is some discomfort for the consulter, there is less expectation than when dealing with a human specialist, because the expectation gap between human specialists and machine agents is reduced.

For the reasons explained above, we make the following two hypotheses.

Hypothesis 1: Increasing the range of consulter wait times can result in willingness of the consulter to wait longer than the time it takes for the human specialist to act.

Hypothesis 2: When the consulter perceives the specialist as a machine, the consulter restricts the topic of consultation and at the same time changes expectations concerning the consultation results. Even if the reply is delayed as a result, the distrust in the consultation can be ameliorated.

We performed experiments to test these hypotheses.

Here, we refer to the time that the consulter can wait for a reply as the waiting time limit.

4. VALIDATION EXPERIMENTS

We use voice modification software to convert the speech of a novice specialist into a machine-style voice to give the consulter the illusion of consulting with a machine agent. In the experiments, the consulter is not informed that the specialist is a human; instead, it is explained that an agent system that we designed is conducting the consultation. The objective is to create in the consulter the mental state that the other party in the consultation is a machine to test if the acceptable range can be extended and if the consulter unease or distrust caused by an additional delay in reply can be ameliorated. The experiment compares the case in which the reply is a human voice and the case in which the reply is as a synthesized voice.

Another aspect of this experiment is to investigate what psychological effects voice modification in consultation can have on the consulter and why those effects occur.

The experiment was conducted for the situation of remote purchase consultation for purchasing a home appliance product. The purchase situation was chosen because the consultation must proceed with awareness
of the buyer’s thinking and many inter-connected factors are involved, so it is very difficult for a novice specialist to do.

The test subject consulters were 15 men and women from 20 to 30 years old who have used call centers. The configuration of the experimental system is illustrated in Fig. 2. The voice modification software intervenes between the specialist and Skype, but there is nothing between the consulter and the system.

We tested the effectiveness of the proposed method in the situation of a remote consultation for purchasing a home appliance products. The experiments were conducted for two cases: consultation with no modification of the novice specialist’s voice and consultation with the voice modified to resemble a mechanical voice. The two cases were presented to the same test subjects on different days.

During the consultation, an intentional consulter wait time was set, and the consulter entered a ‘1’ on a chart at the time they felt that the reply from the specialist was delayed. The time up to when the consulter entered ‘1’ was recorded as the waiting time limit. The main flow of the experiment is shown in Fig 3.

1. The consulter calls the specialist.
2. The specialist asks the consulter about the desired product.
3. When a certain amount of information has been collected, the specialist asks the consulter to wait while a product search is done. In this phase, the consulter is made to wait and the wait time limit is measured.
4. A product is suggested at the time the consulter has marked the chart.
5. If the consulter accepts the suggested product, a questionnaire is given and the consultation ends. If the product is not accepted, steps (3) to (5) are repeated.

Afterwards, we obtained the opinions and feeling of the test subjects regarding the experiment, and considered what psychological effects resulted from the consultation with the human specialist and the agent system. After the experiment, we informed the test subjects that the ‘agent’ in the experiment was actually a person and asked them to evaluate their reactions during the experiment.

5. EXPERIMENT RESULT

The results for the consulter wait time were 59.1 seconds for consultation without modification of the specialist’s voice and 70.3 seconds with voice modification. The voice-modified consultation enabled the consulters to wait longer. This result shows that the permissible range is extended and the consulter does not mind waiting longer when the consulter perceives the specialist as a machine in accordance with hypothesis 1.

The results of the consulter questionnaire are presented in Fig.3. Of the eight evaluation criteria, the score for voice-modified consultation was strikingly higher for smoothness and concentration. The questionnaire result that “When dealing with a machine, I listened carefully, because I thought that if I interrupted to ask a question, I would not get an answer.” suggests that these high scores may result from the consulters’ feeling that when dealing with a human one can listen casually for an opportunity to interject a question and not fully take in what was being said, but if you miss hearing something when listening to a machine agent, you may not be able to hear it again.

Another point is that the specialists felt that the consulters’ manner of speaking differed for the human voice and the modified voice. With the human voice, consulters would often interrupt product explanations with questions in an unstructured way. The overall consultation was also more verbose, with hesitation interjections (such as ‘ahh’ and ‘eeto’ in Japanese). With voice modification, however, specialists felt that the consultation proceeded smoothly, with no interrupting questions during product explanations and little verbosity.
There was also a difference in the number of exchanges for the human voice and the modified voice. For reasons such as described above, there were about 60% as many exchanges with the modified voice as with the human voice. The content of the exchanges also differed. In the case of the human voice, there was verbosity such as the reasons for the consulters' desires and background information in the case of the human voice, but with the voice modification no such verbosity was observed. This difference may be caused by the consultor believing that there is no point in giving reasons and background to a machine. We believe that these factors affect the smoothness of the consultation. For the nervousness criterion, also, the modified voice produced less nervousness in the consulters than did the human voice. We believe this to be a result of the consultor being able to do the consultation at their own pace.

For the overall evaluation, too, the modified-voice consultation was rated above the human voice case. For the criteria of reliability, satisfaction, and distrust, on the other hand, the scores were in some cases higher for voice modification than for the human voice, although the difference was small. The statistical t test (significance level of 5%) reveals that we cannot necessarily say that voice modification is superior to the human voice in these criteria. For hypothesis 2 to hold, more functions must be added.

For the atmosphere criterion, the score was higher for the human voice than for the modified voice. The test subjects expressed feelings such as “the machine voice is cold” and “the voice is a little uncanny.” On that point, however, future improvement may come from use voice modification styles other than the mechanical-style voice alone, such as a female or male voice, or a high-pitched voice or low-pitched voice.

From the 13 out of 15 replies on the questionnaire that the delay in the response was longer for the human voice than for the modified voice, we can conclude that consultation using voice modification can extend the acceptable waiting range of the consultor.

For the item “Was the consultation easier with the agent system or with the human?” on the questionnaire, 12 of the 15 responses indicated that the agent system was easier. Furthermore, some test subjects expressed the opinion that “Because I was consulting with a machine, I could be at ease, even if the consultation was difficult.” We might consider that as a factor in improving the ease of consultation.

In the interview after experiment, it is found that novice experts prefer the proposed system.

6. CONCLUSION

We have proposed here the use of voice modification software to convert the specialist's voice to a mechanical-style voice to present the replies of a human specialist to the consultor as an automatic response with the objective of reducing the distrust produced by delay in replies in remote consultation.

The results of the validation experiment show that the modified voice system has good scores for the wait limit time, the ease of the consultation, the smoothness of the consultation, and the concentration criteria. For the criteria of satisfaction and confidence, however, there was little difference between the modified voice and the human voice, so the proposed system can be considered practical.

In future work, we will experiment with voice styles other than the mechanical style used in the experiment reported here. We think it is necessary to conduct experiments to test whether or not the evaluation is improved when using male or female voices, or high-pitched or low-pitched voices, etc.
REFERENCES


Hiraguri, Y. et al., 1995 “Relationship of Agent Manner and Human Speech in Spoken Dialog” ISPJ Research Reports. SLP, Spoken Language Processing 95, 85-90


Katsuragi A, 2006. “Exploratory Study based on Interviews with Non-professional Telephone Counseling Volunteers: support for non-professionalism, difficulty, methods of coping, and need” Kyushu University Psychological Research 7, 169-174

Katsuragi A., 2010 “Survey of the Literature on the Features of Telephone Counseling and Support for Non-professional Telephone Counseling Volunteers” Kyushu University Psychological Research 11, 145-152

Kobayashi Y et al., 2002: “Testing of Telecommuting using a Multi-point Connection Internet Conferencing System”, IEICE Technical Reports, OIS2002-11


Sagayama T. et al., 2004 “Personified Voice Dialog Agent,” Information Processing 45, 1044-1049


HOW BIG DATA TRANSFORMS THE IT DEPARTMENT TO A STRATEGIC WEAPON

Michael Möhring, Rainer Schmidt, Nadja Wolfrum, Marina Kammerer, Stefan Maier and Sven Höritz
Aalen University – Business Information Systems - Beethovenstr. 1, 73430 Aalen, Germany

ABSTRACT
Big Data is the creation of new flows of information enabled by a number of technological breakthroughs. Large quantities of data of varying structure can now be processed nearly in real-time (e.g. improve sales forecasts and customer analyzes) to improve business process in enterprises and along the value chain. By this means disruptive changes of the information flows within organizations are enabled. In the past IT departments have lost much of their organizational impact due to outsourcing and cloud-computing. Big Data reverses this development by increasing the strategic relevance of IT departments. Therefore, this paper outlines the impact of Big Data on the role of IT departments in enterprises. By providing valuable insights based on large amounts of data, the IT department becomes a strategic weapon.

KEYWORDS
Big Data, Business Intelligence, Data-Warehouse, Data-Mining, IT Business Alignment

1. INTRODUCTION

Big Data is one of the most disruptive information technological developments (Bughin et al 2010). Zikopoulos et al. (2012) characterize Big Data with the three properties - Volume, Velocity and Variety. Big data applications handle data-intensive applications, which are described by a large volume of data, a specific velocity of processing and a data variability of the existing IT solutions. Big data enables handling and analyzing more types of unstructured (e.g. user statements in social media) and semi-structured data as before (LaValle et al. 2011). An example scenario for Big Data is the provisioning of real-time information to mobile users. Based on a stream of position information, information valuable to the mobile user has to be selected from a variety of sources and provided nearly in real-time.

For a long time, IT departments has been regarded as a cost-driver and collection of risks (Carr 2003). IT-departments have been compared with the production of utilities such as electricity (Carr 2003). Therefore, a multitude of outsourcing approaches has been developed. On the other hand, Brynjolfsson et. al 2010 show that the utility model is not applicable to complex IT resources. Complex IT resources may provide strategic advantage.

Big Data can be seen as a further development of business intelligence (BI) to the three "V" (Chen et al. 2012). In comparison to BI it is now possible to analyze large quantities of data from different data sources and with different structure processed nearly in real-time. The business impact of Big Data is shown in various examples of real business cases (McAfee and Brynjolfsson 2012). Significant cost cuts could be achieved by decreasing the estimated and actual arrival time of aircrafts. Furthermore, retailers such as SEARS can increase sales through faster data analysis and thereby better personalized promotions.

Today, research on big data focusses on technological aspects. New technologies such as the globally distributed spanner database attract a large amount of attention (Corbett et al., 2012). There is also plenty of research on the business impact of big data in general. However, only little research is done on the organizational impact of Big Data (Schmidt 2012) and especially the influence on the role of IT departments in organizations. The importance of this theme is supported by an empirical study (worldwide online survey with over 1300 IT managers) from ZDNet "70% will use data analytics by 2013" (ZDnet 2012). Therefore, this article investigates the influence of Big Data on the standing of the IT in enterprises and organizations.
2.  STRATEGIC ADVANTAGES PROVIDED BY BIG DATA

With Big Data the IT department steadily moves up from a "business supporting unit" to an essential and central source of mission critical information.

The possibilities of Big Data and the structure of this solution to improve business processes along the supply chain are illustrated in the chart below. Improved Business processes (e.g. reduce process cost, time and improve process quality) based on a better data quality can be in the enterprise ("B" in Figure 1), at the interface to the suppliers ("A" in Figure 1) and at the interface to the customers ("C" in Figure 1).

![Figure 1: Strategic advantages provided to business by Big Data (according to Fayyad 1996)](image)

2.1 Advantages at the Interface to the Customers

Big Data and the latest IT technology components are fundamental to improve order forecast because the behavior of consumers has changed relevantly (Kuldip and Sandhu 2003). The companies often make all decisions for their consumers and this can be seen best by the strategy of Amazon (Chaffey 2008). Through data mining tools they analyze customer data and develop a product comparison data to gain more detailed knowledge about customer needs. Therefore they divide their consumers into different categories and can offer those products to a wide variety of consumers that meet the same requirements. The data thus collected has to be summarized for best evaluation and usage. Due to this received information, storage can be limited to a small level and therefore expensive storage costs can be reduced.

Based on the knowledge gained by order forecasts, companies are able to improve their value-added chain. Therefore Barnes & Noble¹ are for example able to deliver their customer orders in Manhattan on the same business day on which it was ordered. In future, it will be possible to extend the same day delivery service to more regions.

As social networks and blogs gain in importance, research often focuses on sentiment analysis and opinion mining. Sentiment analysis helps the researchers to derive better marketing strategies through analyzing emotion icons in blog entries. On the basis of these icons it is possible to indicate the users’ emotional state about different or specific products (Pak and Paroubek 2010). Similar to sentiment analysis, opinion mining is a way to obtain the preferences of consumers. By orientating on subjective terms in

¹ (http://www.barnesandnoble.com/help/cds2.asp?PID=8112#3)
documents researchers are able to discover the consumers’ opinion about the topic (Esuli and Sebastiani 2006). In this way hidden knowledge can be revealed. However, these approaches could be seen as an interference with private life and help enterprises to improve product developments, sales forecasts and specific customer requests.

As Big Data supports the decision-making process, therefore decisions can be made faster and in real-time. This (nearly) real-time data could be provided by the IT department as a kind of "live-data-feeds" and different departments - and even other companies (Forbes 2012) - could subscribe to those fundamental data-streams. Especially in the field of market analysis the collection of data has a high impact and significance. Due to that fact more data also offers more space for misinterpretation or false correlations, and if a company relies on false discoveries, the company will not be competitive anymore. Data mining tools as a part of Big Data are in particular applied in the customer relationship management for analyzing the data about present and potential customers, business partners and suppliers (Ngai et al. 2001).

2.2 Advantages in the Enterprise

Nowadays, companies are faced with huge amounts of data (Lynch 2008) - estimated "Walmart collects more than 2.5 petabytes of data every hour from its customer transactions" (A McAfee, E Brynjolfsson 2012) - which need to be captured, stored and cured. This increasing amount of data and interdivisional role poses new challenges to the IT because "more data" not automatically means "better data. In detail the challenge is to get this unstructured large amounts of data in an organized manner. In this way the company get the great opportunity to extract the valuable and essential information because "Data driven decisions are better decisions" and often a better foundation compared to intuition (A McAfee, E Brynjolfsson 2012). Better decisions allow the enterprise to optimize their processes by reducing process costs and time as well as raising process quality. A data analyze with focus on Big Data can lead to accurate forecasts and costumer relationship management and so decisions are more specific. For example a more detailed sales forecast supports a better warehousing and logistical infrastructure. In this way a company gets the opportunity to implement a competitive business strategy.

Continuous analysis of internal data in combination with miscellaneous mechanisms (e.g. thresholds) could start predefined workflows or processes for further action (e.g. fraud detection). On top of that, the IT department could provide a kind of "self-service portal" as a simple to use high level interface that allows the different divisions of the enterprise to create real-time reports that are suited for their individual needs of manage compliance and support audits.

2.3 Advantages at the Interface to the Suppliers

Better sales forecasts based on a good data quality and processing in real-time supports a consistent information flow between the suppliers. Through this they reduce warehousing costs and continuance material flow. Therewith the high level of maturity establishment in the supply chain is secured.

Big Data allow a processing of different data sources for tracking and handle shipping's, through this Supply Chain Event Management (Otto 2003) is more enabled in real-time than in the present. Moreover data from different sources (e.g. also from public internet sites) and in different formats (e.g. ad-hoc text based weather forecasts and notice from organizations) combined with already established internal enterprise information about shipping’s. Furthermore evaluation of suppliers safe costs by stock keeping (e.g. based on better knowledge about vendors and products). Through those new data sources (e.g. online ratings and evaluations of suppliers, public directories etc.) it is possible to respond to changes in the flow of goods at an early stage.

3. CONCLUSION

Big Data creates new strategic advantages for enterprises and IT departments. Data from different sources, formats and quantities can be processed nearly in real time. Sales forecasts, decision-support, sentiment analysis, customer needs and product range can be improved and raise earnings and competitiveness. An integrated implementation of Big Data can boost the standing of the IT in enterprises from a cost-driver to a
strategic weapon. Business can not implement this approach without the IT department because of required specialized knowledge of the data, data structure and data sources in relation to the business case.

Despite the advantages there are also risks associated with the use of Big Data. One of these risks is the data protection (e.g. data from content provider) and the protection of privacy of persons and organizational units (Bollier 2010). Because of the rapid analysis of the data, algorithms could made wrong decisions, which can have fatal impact on business and privacy of people.

Some limitations have to be discussed. Not in all cases a larger quantity of data implies a better quality of data and decisions. For each case a proof of concept is needed. A distinction between industry sectors has to be developed. IT departments in some industry sectors could improve more than other (e.g. internet banks as small retailers) and have a better return on investment. Furthermore, an integrated empirical study with all aspects available to support the argumentation in in all facets has to be done.

The research agenda for the future may contain an empirical study about the impact of Big Data for the standing of it departments and in comparison to different countries and business processes (in and between enterprises). So it may be possible to make this impacts clear for the management and show at which point or interface in the enterprise Big Data generates the highest profit. We propose to combine a qualitative and quantitative approach to differentiate the impact of big data according to business processes and business models. Furthermore risks and possibilities of data (e.g. from external content provider), direct and indirect cost aspects and influencing factors to the IT Business Alignment must be examined.

REFERENCES


LaValle, S. u. a., 2011. Big data, analytics and the path from insights to value. MIT sloan management review, 52(2), S.21–32.


2013/284?tag=nl.e101&s_cid=e101. Last access 2012.11.12

JOB SATISFACTION AMONG IT PROFESSIONALS IN THE PUBLIC SECTOR IN SAUDI ARABIA

Khalid I. Alshitri1 and Abdulmohsen Abanumy2
1National Satellite Technology Center (NSTC) - King Abdulaziz City for Science and Technology (KACST) - Riyadh, Saudi Arabia,
2ICT Department - King Fahed Security College (KFSC) - Riyadh, Saudi Arabia,

ABSTRACT
The purpose of the study is to examine IT professionals' job satisfaction in a public Saudi Arabian organization. The study sample consisted of 44 employees. Employees' job satisfactions were measured by the job satisfaction survey (JSS) instrument developed by Spector. The instrument assessed nine facets of job satisfaction: pay, promotion, supervision, fringe benefits, contingent rewards, operating procedures, co-workers, nature of the work and communication. IT professionals in the public organizations in Saudi Arabia were most satisfied with supervision, coworkers, and nature of work and less satisfied with the operating procedures, promotion, fringe benefits, and clarity of communication within the organization. These finding are in accordance with prior studies and can be particularly useful for providing a comparative and comprehensive understanding of job satisfaction in the IT profession.

KEYWORDS
Job satisfaction, information technology, IT professionals, Public organization, and Saudi Arabia

1. INTRODUCTION

The recruitment and retention of qualified IT professionals are key concerns of any organization. Curtis et al. (Curtis, Krasner et al. 1988) advocated that IT professionals who have superior application knowledge, communication skills, high levels of motivation, team spirit, and dependability are ‘essential’ for the success of an IT project. However, qualified IT professionals are costly and scarce resource, and also exhibit high job turnover resource (Baroudi 1985; Keil, Cule et al. 1998; Alshitri 2008). IT professionals once being trained have a tendency to move to other organizations for better prospects. Lucrative salary, comfortable timings, better environment, growth prospects are some of the factors which prompt an employee to look for a change.

With respect to the situation in Saudi Arabia, lack of skilled IT professionals and high turnover rate of employees depict the image of IT profession in the public organizations in Saudi Arabia (Abdul-Gader 1999; Alshitri 2008). This high turnover has previously been a problem and has been the subject of considerable research since first being identified. Job satisfaction is the main driver of turnover among IT professionals (Baroudi 1985; Chen 2008). Accordingly, how managers manage and encourage these professionals effectively has become a key issue for organizations.

Job satisfaction significantly influences organizational behavior. Most studies have indicated that job satisfaction positively influences product quality, increases customer satisfaction, increases productivity, reduces employee turnover rate, and reduces absenteeism (Spector 1997; Maghrabi 1999; Zhang 2000). Various researchers have defined job satisfaction. Locke (Locke 1969) defined job satisfaction as the “the pleasurable emotional state resulting from the appraisal of one’s job as achieving or facilitating the achievement of one’s job values”. Spector (Spector 1997) on the other hand defined job satisfaction as an individual’s global feeling about their job and the attitudes they have towards various aspects or facets of their job. Job satisfaction thus, has to do with an individual’s perception and evaluation of his job, and this perception is influenced by the person’s unique circumstances like needs, values and expectations. It is “a function of the perceived relationship between what one wants from one's job and what one perceives it as
offering or entailing” (Locke 1969). People will therefore evaluate their jobs on the basis of factors, which they regard as being important to them.

Many researchers have opted for different methods of measuring job satisfaction. The literature review indicates three major scales with regard to subject of job satisfaction. The first is the Minnesota Satisfaction Questionnaire (MSQ) developed by (Weiss, Davis et al. 1967). Second, the Job Descriptive Index (JDI) developed by (Smith, Kendall et al. 1969). Finally, the Job Satisfaction Survey (JSS) developed by (Spector 1985). However, the importance of these scales for measuring job satisfaction stems from the fact that if unreliable scales are used in measuring job satisfaction the result will consequently be incorrect (Hinkin 1995). Therefore, the multi-facets JSS (Spector 1985), was chosen for measuring the levels of employees’ satisfaction for each employee. The description of each facet is summarized in Table 1. The JSS was used in this study because of its high degree of validity and reliability. Construct, discriminant, and convergent validity of the JSS were established by Spector (Spector 1997). Inter-item correlations ranged from 0.61 for co-workers to 0.80 for supervision (Spector 1997). In terms of reliability, internal consistency reliability coefficients for the JSS ranged between 0.60 for the co-worker sub-scale and 0.91 for the total scale (Spector 1997). Also, the JSS was used because of the facet approach which can provide a more complete picture of a person’s job satisfaction than the global approach (Spector, 1997) and it is affordable and easy to administer.

Table 1. Nine facets of job satisfaction with descriptions (Source: (Spector 1997))

<table>
<thead>
<tr>
<th>Facets</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay</td>
<td>Satisfaction with pay and pay raises</td>
</tr>
<tr>
<td>Promotion</td>
<td>Satisfaction with promotion opportunities</td>
</tr>
<tr>
<td>Supervision</td>
<td>Satisfaction with person’s immediate supervision</td>
</tr>
<tr>
<td>Fringe benefits</td>
<td>Satisfaction with monetary and non-monetary fringe benefits</td>
</tr>
<tr>
<td>Contingent rewards</td>
<td>Satisfaction with appreciation, recognition and rewards for good work</td>
</tr>
<tr>
<td>Operating procedures</td>
<td>Satisfaction with operating policies and procedures</td>
</tr>
<tr>
<td>Coworkers</td>
<td>Satisfaction with co-workers</td>
</tr>
<tr>
<td>Nature of work</td>
<td>Satisfaction with type of work done</td>
</tr>
<tr>
<td>Communication</td>
<td>Satisfaction with communication within the organization</td>
</tr>
</tbody>
</table>

Studies on job satisfaction of IT professionals have been carried out since 1980s. In an early study, Baroudi (Baroudi 1985) examined the antecedents of job satisfaction, commitment and turnover intentions for 229 information systems personnel employed within several industries and found that role ambiguity was the most dysfunctional variable for IS personnel accounting for 10.3%, 20.2%, and 22.2% of the variance in turnover intentions, commitment and job satisfaction. Chen (Chen 2008) examines relationships between achievement motivation and job characteristics on job satisfaction among IS personnel. He found that Job characteristics (task identity, professionalism, feedback, autonomy and significance) affect the job satisfaction of IS personnel. He concluded whether IS worker achievement motivation is high or low, IS workers engaged in jobs with high job characteristics have higher job satisfaction.

The vast majority of studies on job satisfaction are associated with the west. However, the need to examine job satisfaction within different cultural contexts has been identified (Maghrabi 1999). Yet, no study has examined job satisfaction among IT professionals in Saudi Arabia. As an attempt to fill this gap, the present study was conducted on IT professionals in a public organization in Saudi Arabia to examine the job satisfaction experienced by IT professionals. More specifically, the objectives of the study were to examine the applicability of an instrument (Job Satisfaction Survey (JSS)) for the assessment of job satisfaction of IT professionals in Saudi Arabia, the levels of satisfaction or dissatisfaction derived from various facets of work, and the effect of several job factors and background characteristics on different aspects of job satisfaction.

2. METHODOLOGY AND RESULTS

2.1 Methodology

The data for this study was primarily collected through a structured questionnaire hosted on the web where respondents answered research questions online. Online questionnaires have their valuable advantages which include: the possibility of a large and geographically dispersed sample size and the low likelihood of
contamination or distortion of respondent’s answer. In addition, using this approach provides the opportunity to conduct surveys more efficiently and effectively than the traditional means. The primary reason for the utilization of the internet was due to cost as well as time saving. The questionnaire was distributed online using gmail.com web tools, which send personalized email invitations to 59 employees. Respondents were given 7 days to complete the questionnaire. The completion of the electronic questionnaires was personally administered and anonymously handled. After all the responses had been collected, they were carefully reviewed and verified. A total of 44 responses were collected and analyzed, which represents a 74.5% response rate. The survey was conducted in January 2013. All instructions and questions were translated from English into Arabic in order to help all participants understand easily these surveys.

The questionnaire instrument consisted of two parts. The first part involved 4 questions regarding basic demographic characteristics of the respondents. The Job satisfaction survey (JSS) comprised the second part of the instrument. This part included 36 questions designed to measure the level of the employees’ job satisfaction levels. The Job satisfaction survey (JSS), designed by Spector (Spector 1985), was used for measuring the levels of employees’ satisfaction for each participant. The questionnaire consisted of a set of 36 items and it assesses nine facets of job satisfaction (pay, promotion, supervision, fringe benefits, contingent rewards, operating conditions, co-workers, nature of the work and communication), as well as overall job satisfaction, see Table 1. The scale was a summated rating in the form of a six-point Likert-type scale ranging from "strongly disagree" to "strongly agree". The questionnaire includes 19 negatively worded items. High score on the scale represent job satisfaction. So the scores on the negatively worded items must be reversed before summing with the positively worded into facet or total scores. The purpose of this questionnaire was to stimulate the employees’ thoughts about their own areas of job satisfaction in relation to the nine facets of the JSS. Individual sub-scale scores for the JSS are computed by summing the appropriate items. Because each item score can range from 1 – 6, each individual sub-scale score can range from 4 – 24. A four would be the minimum score that will result if a person scored each of the items in the sub-scale as a 1, and likewise a score of 24 is possible if all 4 items were scored a 6.

The survey instrument was pilot tested among 5 employees. The pilot results were used to improve the clarity and readability of questions. The data obtained were analyzed by using SPSS for Windows 20.0 program. Data analysis consisted of descriptive statistics and frequency distribution.

2.2 Results

Table 2 profiles the respondents’ demographic characteristics. About two-thirds of the respondents were less than 30 years of age and female. More than 82% of the respondents had completed bachelor degree or above. About two-thirds of the respondents had been working for less than two years.

Table 3 presents the means and standard deviations obtained for the JSS. The mean scores of all the JSS sub-scales ranged between 14.80 and 20.07. The sample of participants obtained the highest scores on the supervision (m=20.07; SD=3.61), coworkers (m=19.43; SD=3.05), and nature of work (m=19.07; SD=3.41) sub-scales and the lowest score on the operating procedures sub-scale (m=14.80; SD=2.65). The standard deviations of the sub-scales are fairly similar, all ranging from 2.65 to 4.18.

The results of this study suggest that IT professionals are most satisfied with their supervision, coworkers, and nature of work. Satisfaction towards supervision means IT professionals feel their supervisors are competent, fair, show an interest in their feelings and are likeable. They seem to prefer working in environments where the immediate supervisor is understanding, friendly, offers praise for good performance, listens to employees’ opinions and shows personal interest in them. An immediate supervisor’s behavior is, however, a determinant of job satisfaction (Spector 1997). Satisfaction towards coworkers means IT professionals feels their coworkers competent, supportive, and friendly. They seem to prefer working in a friendly, supportive, and team-based work environment. Satisfaction towards nature of work means that IT professionals enjoy the type of work they are doing, their work is meaningful and there is a sense of pride towards their job. They seems to prefer work which is mentally challenging by providing them with opportunities to use their skills and abilities and offer a variety of tasks, freedom, and feedback on how well they are doing. The low mean scores obtained for the operating processes variable means that IT professionals do not necessarily prefer working in tight operating policies and procedures.
Table 2. Profile of IT professionals

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>36.4</td>
</tr>
<tr>
<td>Female</td>
<td>28</td>
<td>63.6</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 26 years</td>
<td>16</td>
<td>36.4</td>
</tr>
<tr>
<td>26 – 30</td>
<td>17</td>
<td>38.6</td>
</tr>
<tr>
<td>31 – 35</td>
<td>9</td>
<td>20.5</td>
</tr>
<tr>
<td>36 – 40</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Master</td>
<td>9</td>
<td>20.5</td>
</tr>
<tr>
<td>Bachelor</td>
<td>27</td>
<td>61.4</td>
</tr>
<tr>
<td>College/Diploma</td>
<td>7</td>
<td>15.9</td>
</tr>
<tr>
<td>Tenure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 years or less</td>
<td>29</td>
<td>65.9</td>
</tr>
<tr>
<td>3 – 5 years</td>
<td>9</td>
<td>20.5</td>
</tr>
<tr>
<td>6 -10 years</td>
<td>5</td>
<td>11.4</td>
</tr>
<tr>
<td>11 -15 years</td>
<td>1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

These findings are in line with other studies (Spector 1997; Lumley, Coetzee et al. 2011). In comparison with Spector’s (Spector 1985) study, the individuals generally felt the same levels of satisfaction towards supervision, nature of work, and co-workers. According to research findings by Lumley et al. (Lumley, Coetzee et al. 2011), individuals tend to have high levels of satisfaction towards supervision, nature of work, co-workers and fringe benefits. In this study, IT professionals seem to be less satisfied with the operating procedures, promotion, fringe benefits, and clarity of communication within the organization.

Table 3. Means and standard deviations of IT professionals’ job satisfaction sub-scales

<table>
<thead>
<tr>
<th>Job satisfaction sub-scales</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Means</th>
<th>Standard deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay</td>
<td>9</td>
<td>24</td>
<td>18.34</td>
<td>3.54</td>
</tr>
<tr>
<td>Promotion</td>
<td>6</td>
<td>23</td>
<td>15.05</td>
<td>3.52</td>
</tr>
<tr>
<td>Supervision</td>
<td>11</td>
<td>24</td>
<td>20.07</td>
<td>3.61</td>
</tr>
<tr>
<td>Fringe benefits</td>
<td>6</td>
<td>24</td>
<td>15.13</td>
<td>3.62</td>
</tr>
<tr>
<td>Contingent rewards</td>
<td>10</td>
<td>24</td>
<td>18.39</td>
<td>3.85</td>
</tr>
<tr>
<td>Operating procedures</td>
<td>7</td>
<td>20</td>
<td>14.80</td>
<td>2.65</td>
</tr>
<tr>
<td>Coworkers</td>
<td>10</td>
<td>24</td>
<td>19.43</td>
<td>3.05</td>
</tr>
<tr>
<td>Nature of work</td>
<td>12</td>
<td>24</td>
<td>19.07</td>
<td>3.41</td>
</tr>
<tr>
<td>Communication</td>
<td>7</td>
<td>23</td>
<td>15.84</td>
<td>4.18</td>
</tr>
<tr>
<td>Overall job satisfaction</td>
<td>120</td>
<td>203</td>
<td>156.11</td>
<td>19.43</td>
</tr>
</tbody>
</table>

3. CONCLUSION

Empirical research in countries other than North America and Europe, with different cultural and environmental conditions, can be particularly useful for a comparative and comprehensive understanding of job satisfaction in the IT profession. The results provide additional support for the notion that IT professionals in the public organizations in Saudi Arabia are most satisfied from supervision, coworkers, and nature of work. Moreover, it seems that top management in Saudi Arabia can enhance employees’ satisfaction by adopting management styles that encourage employees involvement in problem solving and decision making, inspire people and create a culture of excellence that helps them doing their job, reward and recognize for good work, encourage employees to develop their skills, knowledge, and capabilities so they can advance in their career, and encourage cooperation and working as a team.

Of course, it might be premature to generalize the findings reported here to all IT professionals working in the public organization in Saudi Arabia. The study is based solely on data from one organization. There is a need for additional research to obtain a better comprehension of the factors affecting job satisfaction of IT
professionals in Saudi Arabia. Future studies might focus therefore on collecting data from other organizations in order to validate and enhance the results from this study and to investigate whether various organizational structures encourage or prohibit job satisfaction. Finally, the results of this study may not be generalizable to other types of organization (e.g., private), which differ in many aspects from public organizations, and thus differences could be observed. Future studies might focus therefore on examining IT professionals’ job satisfaction in the private sector in Saudi Arabian organization.

REFERENCES


ACQUISITION OF CHARACTERISTIC TREE PATTERNS WITH VLDC’S BY GENETIC PROGRAMMING

Shohei Nakai¹, Tetsuhiro Miyahara¹ and Tetsuji Kuboyama²

¹Graduate School of Information Sciences, Hiroshima City University, Hiroshima 731-3194, Japan
²Computer Centre, Gakushuin University, Tokyo 171-8588, Japan

ABSTRACT
Knowledge discovery from structured data is an important task in realizing knowledge based information systems. We propose a learning method for acquiring characteristic tree patterns with VLDC’s from positive and negative tree structured data using Genetic Programming. We report experimental results on applying our method to glycan data.

KEYWORDS
Knowledge discovery, learning, genetic programming, tree structured data

1. INTRODUCTION

Tree structured data have been rapidly increasing. Finding characteristic patterns from given data is a basic task in data mining and machine learning. Knowledge discovery from structured data is an important task in realizing knowledge based information systems. In this paper, we focus on acquisition of structured knowledge from tree structured data. Genetic Programming (GP) [1] is an evolutionary learning method of dealing with structural representations (tree structures) by extending genotypes in Genetic Algorithm (GA). By using tree structures, we are able to manage structured objects such as formulae and programs that are difficult to manage using usual GA methods.

Glycan data are examples of tree structured data. Glycans are the third most important class of biological molecules following nucleic acids (DNA) and proteins. Because of its complicated structure, glycan structural and functional analysis has not progressed as rapidly as that of nucleic acids and proteins. In this study, we propose a method that employs edit distance between tree patterns and tree data and obtains characteristic tree patterns with VLDC’s [4] from positive and negative examples using genetic programming. A VLDC (Variable-Length Don’t Care) is a structured variable that can be substituted by a part of tree data.

We discuss related work. Although there are many researches on tree patterns with VLDC’s, no previous researches consider learning of characteristic tree patterns with VLDC’s from positive and negative tree structured data. Our method can be applied to general types of tree structured data other than glycan data. In related research [2], a method for extracting characteristic tag tree patterns, different types of tree patterns, by using genetic programming has been proposed.

This paper is organized as follows. In Section 2, we introduce tree patterns with VLDC’s. In Section 3, we define our data mining problem of acquiring characteristic tree patterns with VLDC’s and we present our method using genetic programming to solve the problem. In Section 4, we report experimental results on glycan data.

2. PREPARATION

In this research, we use tree structured patterns, called tree patterns with VLDC’s, in order to represent characteristic structures of tree structured data. A tree pattern with VLDC’s is referred to simply as a tree pattern. Tree patterns has data as node labels and VLDC variables that can be substituted by a part of tree data. Two types of VLDC variables, Path-VLDC’s and Umbrella-VLDC’s, are considered.
A Path-VLDC is a structured variable that can be substituted by part of the path from the root to a leaf of a tree. In the description below, a Path-VLDC is indicated by “|”. An Umbrella-VLDC is a structured variable that can be substituted by part of the path from the root to a leaf of a tree and all subtrees emanating from the nodes of the path, except possibly at the lowest node of the path. In the description below, an Umbrella-VLDC is indicated by “Λ”.

![Figure 1. Examples of Tree patterns](image)

The edit distance treedist(T₁, T₂) of a tree T₁ and a tree T₂ is defined as the minimum of summation of costs of edit operations (node deletion, node insertion and node label replacement) to transform T₁ to T₂[3]. The edit cost for node deletion, node insertion and node label replacement is set as 1 for each operation.

Let S be the set of all possible substitutions to VLDC variables in a tree pattern P. The tree obtained by applying a substitution s ∈ S to P is denoted by P(s). The edit distance treedist(P, T) of a tree pattern P and a tree T is defined as the minimum of edit distance treedist(P(s), T) of P(s) and T. That is, we define treedist(P, T) = minₚ∈S treedist(P(s), T)[4].

![Figure 2. Edit distance of tree T₁ and tree T₂](image)

![Figure 3. Tree data T that matches tree pattern P](image)

3. ACQUISITION OF CHARACTERISTIC TREE PATTERNS WITH VLDC’S BY GENETIC PROGRAMMING

We say that a tree pattern P matches a tree T if the edit distance of P and T is 0, and that P does not match T if the edit distance of P and T is greater than 0. Our data mining problem and the algorithm for the problem are as follows.

**Problem of Acquiring Characteristic Tree Patterns with VLDC’s:**

**Input:** A Finite set D of positive and negative tree structure data.

**Problem:** Find characteristic tree patterns with VLDC’s of high fitness by using GP.

In this research, tree patterns with VLDC’s are used as individuals of GP. The fitness of a tree pattern P is defined as (the ratio of positive examples in D that P matches + the ratio of negative examples in D that P does not match) / 2. The positive examples distance sum of a tree pattern P is defined as the summation of all edit distance of P and all positive examples in D. That is, we define the positive examples distance sum of a tree pattern P as ∑ₚ∈Pos treedist(P, T), where Pos is the set of all positive examples in D.

**Algorithm for the Problem of Acquiring Characteristic Tree Patterns with VLDC’s:**

1. Calculate node labels, relationships between the upper and lower node labels, the maximum tree size and the maximum number of children from positive examples.
2. Generate the initial population in a random way and based on the values calculated in 1.
3. Evaluate the fitness of tree patterns as individuals.
4. Depending on the experimental setting, perform either step 4.a or 4.b.
   4.a Sort individuals in the descending order of fitness.
   4.b If the difference of fitness of individuals is larger than a threshold, sort individuals in the descending order of fitness. Otherwise, sort individuals so that an individual with smaller positive examples distance sum is in an upper position.
5. Perform genetic operations such as crossover, mutation, inversion and reproduction, and generate individuals of the next generation. (Fig. 4 shows an example of performing crossover.)
6. If the generation reaches the maximum number of generations, then terminate the whole process. Otherwise, the population of the next generation produced in step 5 is used as the population of the current generation and the process returns to step 3.

The size of a tree is the number of nodes of the tree. The size of a tree pattern is the number of nodes without VLDC’s of the tree pattern. If the size of a tree pattern P is larger than that of a tree data T, at least one edit operation is needed when transforming P to T. In this case, because the edit distance of P and T is greater than 0, P does not match T. If the size of a tree pattern P is larger than that of the tree data T_M with the largest size in the negative examples, then P does not match all negative examples. Using this property, we can reduce the time required to calculate fitness. This does not pose any problem for calculating fitness, because it is carried out only to determine whether or not P matches negative examples.

![Figure 4. Example of crossover of tree patterns](image)

### 4. EXPERIMENTS

We have implemented our GP-based method for acquiring characteristic tree patterns with VLDC’s from positive and negative tree structured data. For experimental data, we used 176 positive examples and 304 negative examples of leukemia-related data available on the KEGG GLYCAN database. The GP parameters are shown in Table 1.

<table>
<thead>
<tr>
<th>Number of individuals</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of crossover</td>
<td>0.7</td>
</tr>
<tr>
<td>Probability of mutation</td>
<td>0.1</td>
</tr>
<tr>
<td>Probability of inversion</td>
<td>0.1</td>
</tr>
<tr>
<td>Probability of reproduction</td>
<td>0.1</td>
</tr>
<tr>
<td>Selection method</td>
<td>Roulette wheel selection, tournament selection (size 4), elite preservation (size 10)</td>
</tr>
<tr>
<td>Maximum number of generations</td>
<td>200</td>
</tr>
</tbody>
</table>
Using the same GP parameters, we performed experiments of acquiring characteristic tree patterns with high fitness using 4.a and 4b in the GP selection of our algorithm as shown in section 3.

Experiment A: individuals are sorted only by fitness in the GP selection using 4.a.

Experiment B: individuals are sorted based on fitness and positive examples distance sum in the GP selection using 4.b.

We performed 30 runs in each experiment setting. The individual with the highest fitness is called the \textit{best individual}. Figs. 5 and 6 show average values of fitness of the best individuals in each generation in both experiments. Table 2 shows average values of the ratio of matched positive examples, the ratio of unmatched negative examples, the fitness of the best individuals of the final generation. Table 2 shows also average run time. Fig. 7 shows average size of individuals which do not preserved as elites in each generation in both experiments.

Fig. 8 shows the best individual in the final generation of 30 trials in experiment B. Table 3 shows the ratio of matched positive examples, the ratio of unmatched negative examples, and the fitness of the best individual. Glycan data that match the best individual is shown in Fig. 9. The graphs in Figs. 5 and 6 and the fitness of Table 2 mean that we have similar outcomes for both experiments A and B.

Experiment B with positive examples distance sum of has a smaller size and slightly faster run time than experiment A without positive examples distance sum, as shown in Fig. 7 and Table 2.

From these results, we can say that individuals in the final generation have high fitness for both experiments. Therefore, our method successfully obtains tree patterns that match many positive examples and few negative examples.

Figure 5. Fitness of experiment A

Figure 6. Fitness of experiment B

Table 2. Fitness and run time of experiment A and B

<table>
<thead>
<tr>
<th></th>
<th>Experiment A</th>
<th>Experiment B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of matched positive examples</td>
<td>0.700</td>
<td>0.714</td>
</tr>
<tr>
<td>Ratio of unmatched negative examples</td>
<td>0.916</td>
<td>0.909</td>
</tr>
<tr>
<td>Fitness</td>
<td>0.808</td>
<td>0.811</td>
</tr>
<tr>
<td>Run time</td>
<td>8,835 (sec.)</td>
<td>8,089 (sec.)</td>
</tr>
</tbody>
</table>

Figure 7. Individual size of experiments A and B
5. CONCLUSION

In this paper, we have proposed a method for acquiring characteristic tree patterns with VLDC’s with high fitness from positive and negative tree structured data, by using Genetic Programming. Experiments on some glycan data have shown that our method successfully obtains characteristic tree structured patterns with respect to the glycan data.

Since we did not utilize specific knowledge about glycan data in our experiments, our method is applicable to other tree structured data. As future work, we consider to apply our method to other interesting tree structured data such as web documents.

REFERENCES

NFC CITY: CO-LOCATING NFC SERVICES IN A MULTI-SERVICE TRIAL APPROACH

Dag Slettemeås1, Bente Evjemo2, Sigmund Akselsen2, Arne Munch-Ellingsen2, Sindre Wolf3 and Victoria Jørgensen3

1National Institute for Consumer Research (SIFO) - Sandakerveien 24C, P.O. Box 4682 Nydalen, N-0405 Oslo, Norway
2Telenor Research and Future Studies - Sykehusveien 23, P.O. Box 6403, N-9294 Tromsø, Norway
3University of Tromsø - Faculty of Humanities, Social Science and Education, N-9037 Tromsø, Norway

ABSTRACT

The ambition of this paper is to make a preliminary assessment of a field trial effort related to NFC service development, identifying some challenges in terms of research design. The paper has not focused on the integration of the field trial/user experiences with the wider question of developing integrated “smart” ecosystems. However, it acknowledges how consumers (and UC research) can be valued as a “next step” in the advancement of information systems, through automation and data capture related to consumer usage. Making “smart services” the centre of ecosystem networks will influence how future information systems can be conceptualized.

KEYWORDS

NFC, field trial, smart phones, mixed method

1. INTRODUCTION

The ambition of this paper is to present a multi-service field trial effort, including pilot users, which is part of a large four-year technology innovation project. The aim of the field trial is to test and evaluate Near Field Communication (NFC) services made accessible through NFC-enabled smart phones. Findings from the field trial will inform the main project, which partly seeks assess the potential for a sustainable “NFC ecosystem”, involving operators, service developers, network infrastructure, trusted service managers (TSM), stakeholders/users – and consumers. However, as consumer-centric scenarios have traditionally been associated with ubiquitous computing (UC), the project will draw inspiration from perspectives that evaluate the benefit of UC research for IS management practice and research, in particular when facing “smart” pervasive systems (Fleisch & Thiesse 2007).

However, the aim of this paper is merely to focus on the research efforts pertaining to consumers and service encounters, while prospective papers will evaluate how consumer data (real-time log data, aggregate use data, consumer feedback, consumer service co-production, etc) can be fruitfully integrated in the extended informational loop of “smart” ecosystems.

A range of NFC pilot studies are presently being conducted, but there are few trials of this scale in operation (Medaglia et al., 2011), involving multiple services to be tested over an extended period of time, using authentic users in a realistic service environment. Thus, the pilot study in this field trial needs to develop new procedures and research methods in order to arrive at valid knowledge. Below we present the NFC technology and smart phones, the trial design, the services to be tested, and the data/methods to be used.

2. SMART PHONES AND NFC

NFC has become a central feature in many innovation projects as the technology promises to simplify the interaction between users and tasks in physical environments. So far, few commercial systems and services have been implemented, but this picture is changing fast as demos and trials mature and public awareness is
As NFC is a short range wireless technology, proximity becomes a central feature of service development. Users may experience seamless activation of various services through “tapping” portable devices (cards or smart phones) at the NFC service access points.

In this innovation project we prioritize smart phones as the inquiring device, since this technology is already widely diffused in the population. A recent survey conducted in Norway reveals that 57 percent of the Norwegian population has adopted smart phones, while the adoption figure is 78 percent in the age group 18 to 29 years (Slettemeås & Helle-Valle, 2012). The smart phone is omnipresent and users bring with them these devices everywhere. Consequently, smart phones help establish mobility and ubiquity as core elements of the consumer experience.

Still, the anticipated pervasiveness of the smart phone, producing a flexible and mobile consumer, does not automatically translate into successful NFC service adoption. The big question is how new NFC services actually affect individual consumers; their activities, preferences and consumption practices in everyday life. Research must also address constraints and structural effects on service adoption, and potentially contradictory or paradoxical behaviors (Mick & Fournier, 1998). In other words, the research design and analytical framework must aspire to explore, interpret and explain these phenomena in an integrated manner (Myers, 2009).

3. NFC CITY MULTI-SERVICE TRIAL

The key feature of the project is the multi-service trial held in a geographically defined area – the NFC City. The clustering of NFC services, access points and users enable a simultaneous study of a wide range of aspects relating to technical factors and adoption issues without over-stretching resources. This clustering also has a theoretical vantage-point; the assumption that proximity and abundance of services will uphold user curiosity and secure faster technological maturity.

The geographical area selected for exploring new NFC services is the city of Tromsø, Norway, including the University of Tromsø campus. This implies that students constitute the main group of pilot users. Fifty users have been recruited and equipped with NFC-enabled smart phones. The phones were donated to the users to create a stronger sense of ownership and to establish ‘real’ relations and realistic use practices.

The trial period will last for eight months. The reason for this duration is to secure longitudinal data revealing service adoption maturity and/or service rejection. The ability to study long-term effects in real or semi-realistic use situations is rare, and adds to the potential validity of research results. The researchers “on the ground” have so far attended to the campus-specific NFC services, while new services will be phased in consecutively. The project design has been modified to enable this phasing-in of services. This is a more cumbersome method, and creates challenges in terms of SIM-card replacement, issuing and management of services, and the ability to study more or less “integrated” services. Below we provide a list of services included in the trial, as well as methods for gathering data for future analysis.

4. NFC SERVICES

The services included in the multi-service trial span a range of categories, from information access and information sharing, to ticketing, payment, loyalty/bonus, and physical access. These services have been developed by project partners from different sectors. The different services rely on either of the three modes that NFC can operate in; 1) the card emulation mode, for sensitive information, transaction and authentication; 2) peer-to-peer communication, pairing two mobile devices for information exchange; and 3) read/write mode, for initiating and accessing information services on the phone (Medaglia et al., 2011).

The multi-service trial includes a range of information services (smart posters). These are placed in strategic spots on the campus area, enabling users to activate relevant and updated information about menus, events, timetables, syllabuses, news, etc. In addition there are social networking register-services (through Foursquare check-in) and service endorsements (through Facebook likes). A set of context sensitive social networking applications have also been developed (Andersen et al., 2011).

Furthermore, a NFC fitness guide has been developed to assist users while exercising in gyms. This is essentially an information service where NFC tags are attached to posters and work-out machines.
Furthermore, trial users are themselves engaged in service creation, being equipped with programmable NFC tags. In this way they get used to the NFC technology and simple functionalities (such as controlling phone applications and accessing websites and social networks). These services are all in operation and data are being gathered continuously on technical aspects and user experiences.

In addition, several pending services are being developed, soon to be launched in the multi-service trial. One service is a loyalty application, which includes prepaid coffee cards that are activated by tapping phones at point-of-sale devices in student cafés. The ticketing service is a complex application relying on card emulation mode. The transaction and security features of this service are demanding and require a different approach than the typical information services. The same goes for the payment service, which will be tested in a separate scheme, beyond the NFC City framework. Physical access is the last service to be introduced and enables students to access apartments by tapping their phones at the door lock.

5. DATA AND METHODS

From the service descriptions above, the diversity in applications, use contexts and benefit/risk scenarios are acknowledged. The main ambition is to evaluate the potential for adoption and “co-existence” of services, both in technical terms and in terms of user convenience and learning effects. In order to gather rich data for analysis a triangulated approach is devised (Kelle, 2005). In this way we can explore the NFC service encounters from different perspectives, using different data gathering techniques. To integrate the triangulation effort properly, a mixed method approach (Tashakkori & Teddlie, 2010) is employed. In the following we specify the data gathering techniques employed:

- Surveys/questionnaires; the participants had to answer a questionnaire prior to the trial in order to get an account of demographics, attitudes, expectations and previous experiences with related services. There will be a follow-up questionnaire after the trial period is over in order to discern changes in attitudes, routines, needs and use behaviors.

- Individual interviews; a major part of the data will be individual interviews with a selection of participants, either randomly selected, or selected on the basis of other criteria such as use-intensity, demographic background, etc.

- Participant observation; some students will figure as ‘research assistants’, providing opportunities for deeper social engagement in certain use-situations. Participant observation (including walk-along interviews) enables direct access to situational use experiences. This way of getting data may elicit a richer understanding of routine practices such as non-verbal, bodily behaviors.

- Focus groups; gathering pilot users will enable dynamic interchange of ideas in terms of existing experiences with smart phones and in terms of deliberations on new functionalities and use scenarios. In addition focus groups will be hosted as workshops, i.e. as joint efforts in programming personal NFC tags.

- Personal diaries; to achieve personal accounts over time, the project encourages diary writing at specific points in time, in order to gather self-reflection data on specific service encounters or larger contextual matters.

- Social networking; a dedicated Facebook group has been established where researchers and pilot users can engage in information exchange. The main idea is to use this space as an arena for developing new ideas, for recruiting users to specific data collection events, to get feedback on NFC pilot services in operation, etc.

- Use logging: data from actual use of the various services will be gathered from phone logs, access point logs, and ‘help desk’ logs. These data will complement the statistical as well as the qualitative data in the method triangulation effort.

6. RESEARCH CHALLENGES

As the NFC City multi-service field trial has reached the midway junction, a wide range of data has already been gathered and systematized. So far, only preliminary and unstructured analyses have been performed, primarily to adjust the research design and to modify service development. Below we list three research challenges we have identified at this point in time:
Multi-phased service implementation; the phasing-in of services at various points in time causes practical as well as analytical challenges. Services cannot be studied in a holistic manner, and the ability to identify how users react to several services simultaneously is lost. This includes the technical, practical and social factors that accompany a multi-service scenario (Barkhuus & Polichar, 2011).

Longitudinal approach; this approach was devised to address synergy and learning effects, and to study overall technology/service maturation among users (Dourish, 2003; Salovaara & Tamminen, 2009) in an integrated manner. As some services are still lacking, the project seeks to upscale the research effort and intensity on user experience at the end of the trial period (when all services have been introduced) in order to address this challenge. Another remedy will be to extend the trial period for specific services.

Analysis based on method triangulation; when sufficient data have been gathered (cf. the list of data gathering techniques above) the analytical strategy must properly and correctly investigate and integrate the assorted data at hand. Although employing a mixed method approach, with extensive research experiences to lean on, the “data field” is new ground and requires innovative and explorative perspectives. This calls for an interpretative rather than a positivistic approach (Walsham, 1993).

7. CONCLUSION

The ambition of this paper has been to make a preliminary assessment of the field trial effort related to NFC service development, identifying some challenges in terms of research design. The paper has not focused on the integration of the field trial/user experiences with the wider question of developing integrated “smart” ecosystems. However, it acknowledges how consumers (and UC research) can be valued as a “next step” in the advancement of information systems, through automation and data capture related to consumer usage (Fleisch & Thiesse 2007). Making “smart services” the centre of ecosystem networks will influence how future information systems can be conceptualized.

ACKNOWLEDGEMENT

Thanks to The Student Welfare Organization in Tromsø for contributions to the design and implementation of several NFC services included in the trial.

REFERENCES


Walsham, G. 1993. Interpreting Information Systems in Organizations, Wiley, Chichester,
PERSONALIZED ADAPTIVE SYSTEM FOR TERM ENROLLMENTS BASED ON CURRICULUM RECOMMENDATIONS AND STUDENT ACHIEVEMENT

Vangel V. Ajanovski
Faculty of Computer Science and Engineering - Ss. Cyril and Methodius University, Skopje, Macedonia
http://www.finki.ukim.mk/en/staff/vangel-ajanovski

ABSTRACT
During the process of term enrollment in Macedonian universities, the students submit an enrollment application for the next term with a selection of courses to be approved by the academic adviser. The course selection submitted by the students can have great impact on the achievement and can even indirectly influence the overall duration of the studies. With growing number of students and increasing complexities of curricula, the academic advisers are barely able to keep-up and offer relevant recommendations to the students. The system that is described in the paper, guides the students in their choice of courses and aims to replace most of the work of the academic adviser. The guidance is a coordinated effort of a course recommendation system and a web-based what-if component that forecasts the possible future term enrollments and course choices of the student, while at the same time allows the student to monitor her progress have a basis for comparison with the overall success of her peers. The what-if component enables the student to view various scenarios – change her study load, plans and programs, rearrange courses, in order to come up with a suitable plan leading to graduation. This paper also discusses the possibility of alignment of the personal curriculum recommendations to the general curriculum guidelines developed by organizations such as the ACM and IEEE; using elements from such recommendation to enable a study plan that is strongly correlated to the students skills and knowledge areas of interest.

KEYWORDS
Recommendation system, course enrollments, academic performance.

1. INTRODUCTION

One of the major administrative processes at Macedonian universities – the term enrollment, starts few weeks before the start of each following academic term and ends a week after the start of the courses. In this short period all the students have to submit an enrollment application for the next academic term with a selection of courses which then has to be approved by an academic adviser. Each student can choose a list of courses to enroll and is free to decide on the number of courses and thus the total work load for the next semester, up until 40 credits per term. The adviser's role consists mainly in helping the student to make a smarter choice.

The latest changes of legislation in Macedonia mandate a certain amount of free choice to be present in the study programs. Only 50% of the courses in a program can be mandatory, while the rest of the courses are to be elected from other programs at the same institution, while at the same time at least 10% choice should be allowed from other institutions at the university. Thus, an average student taking a total of 39 courses during the 4-year studies, will have approx. 19 mandatory courses that constitute the core of the program, and 20 freely elected courses (at least 4 of them from another institution).

Nowadays, the undergraduate students much more choice of how to steer towards a successful career than in the past. This goes hand in hand with the constant demands of the industry to have more breadth in the studies and cover specializations that were not existing in the past. There is, however, an important side effect of giving more responsibility at the hands of the student. In a situation with surging unemployment rates and where students cannot be sure if they will be able to have a successful start after graduation and earn their living, any choice that can influence their achievement and can lead to a longer duration of the studies makes a significant burden.
2. THE ROLE OF ACADEMIC ADVISER AND VIRTUAL ADVISERS

The role of the academic adviser is to help and guide the students towards their interests, by making the most adequate course selections and in that way leading the students to a successful completion of their studies. As an example, the advisers know which courses can be harder for the student to pass, and depending on the student background they can give warning against course selections that are not advisable because they can introduce overload to the student and in the end the student might fail one of them. It is up to the student to use the advice, but need not be strictly followed, the only formal rule being: max number of ECTS credits per term given by law and course prerequisites according to the study program have to be met. It is obvious that the academic advisers cannot be appointed from administrative staff, since the process requires an academic background and truly understanding the intricacies of the various courses.

Figure 1. Full tree of just two of the six types of dependencies relevant for a single study program.

Figure 1 shows a graph of dependencies – where the vertices represent courses and the edges represent dependencies. The edges are labeled in various colors depending on the type of dependency. For example, one such type of dependency – a prerequisite, states that a student needs a passing grade on one course, before enrollment in the next course. The graph is different for each study program and there can be as many as 20 such graphs that the adviser has to have in mind. In a previous study (Ajanovski, 2011), we discussed in more details the need of a true academic adviser and we presented a prototype virtual academic adviser component with a simple personalization engine – as an add-on to the existing system (Ajanovski, 2010). This gave the students time and freedom to check options and make a decision themselves, or use the scenarios from the software as a basis for discussion with the adviser. The initial prototype was fully implemented and now it uses a visually rich dashboard, used for monitoring the students progress.

Figure 2. Screen-shot of the map of past term enrollments of a regular student.

Figure 2 shows a typical map of all term enrollments of a regular student. Each row represents a term, and each box in the row is a course enrolled in that term. The last (active) term is on top. Each box shows: the name of the course, whether the lecturer has certified minimum required presence of the student at lecture hours and is allowed to take exams; the final grade of the student and number of ECTS credits awarded upon finishing the course.

The boxes are color coded according to the following scheme:

- white boxes represent courses that were finished with success (grade in the range 6..10);
- saturated red indicates courses that the student has explicitly failed (grade is 5);
• pale red boxes represent courses that are finished, not yet successfully passed, but the student still has a chance to take another exam in the near future (grade is null);
• green boxes represent currently active courses (no such situation in the period of enrollment).

Figure 3. Another student’s map with focus only on problematic courses.

Figure 3 depicts a map of a student that was not very successful during the past terms. In the figure we give emphasis on one course of the several courses that were failed. It can be seen that the student has enrolled that course for the third time. This was a core mandatory course, so after all deadlines have passed, he had to enroll it once again in the first next available term. It can also be seen that in some terms there are only 4 courses, while in others there are 6 — the reason being unfulfilled prerequisites for all other courses on offer for the former, and the student trying to keep up with the pace for the latter.

The dashboard shows the speed in acquiring credits and the student can compare with the average of his generation and with the historical average of previous generations at the same year of studies. The future academic terms are mapped according to the average speed of studying, and future courses are marked yellow starting from the first following term (label “+1”) and counting upwards for the estimated number of future terms. The dashboard also gives options to change the speed of studying and change programs.

Figure 4. Two possible future scenarios that the student from Figure 2 can take.

Figure 4 two possible scenarios that the same student from Figure 1 could take in the future. In order to save space, the past terms of the student are not shown. The left part in Figure 4 shows the do-nothing scenario. It can be noted that it ends with the term labeled “+6”, meaning that the student will study for 6 more terms. If we add the past 4 terms shown in Figure 2, we get to the total of 5 years instead of the regular 4 typical for the study program. A careful observation will uncover the fact that the term “+5” is missing and although “+4” has free space available, a course has been moved to term “+6”. The student will be forced to have a free term “+5” and the reason for this lies in the fact that the problematic course that was left alone is a mandatory one and cannot be taken in terms “+1” through “+4” due to dependencies from courses in those terms. Also, this course is not on offer in odd-numbered terms, so the student has no other option but to wait.
There are also some other choices. The right part in Figure 4, shows an alternative scenario where the student has decided to change to another study program (towards new specialization). It should be re-stated that the system takes into account all inter-dependencies and course prerequisites and proposes scenarios that are realistic and achievable even in cross-program context. Extensions of the presented graph in Figure 1, connect all graphs from separate programs with cross-program dependencies and cross-program course associations and can be used to estimate which past efforts of the student will be recognized officially in the new program. So, once the future terms are remapped it can be seen that with an optimal plan and a bit more luck in terms “+1”, “+2” and “+4”, the student can still manage to finish the studies within the 4-year time frame. Still, although the plan is technically achievable, whether it will succeed depends only on the ability of the student to follow-up and keep the pace throughout.

3. THE INTRODUCTION OF A RECOMMENDATION ENGINE

Similar to other earlier efforts (such as: Mahony and Smyth, 2007) to ease the use and make the system more flexible and more adaptive to students needs we have experimented with the integration of a recommendation system (the open-source software Easyrec). The Easyrec system allows a straightforward import process of historical data and the database was filled with past student actions. The intention was that this system would be used within our virtual academic adviser when offering course recommendations for the free slots in the map. It should be stated in advanced that the course recommendation engine cannot help with courses that are mandatory for all students, or have a fixed place in the study program.

The engine setup is similar to an online store whereas – the action of buying a product is equivalent to enrolling a course, and rating the book is equivalent to receiving a grade in the course. With such a setup, the recommendation engine helps when the student has a free choice of a course (see Figure 4, slots labeled “Free choice”). The recommendations received are of type “students who have enrolled the courses that you have, have also enrolled <list of courses>” and “students that rated higher on courses that you have rated high, have also enrolled <list of courses>”. Such recommendations are combined into a single prioritized list.

Using such a system helps to increase the likelihood of students choosing elective courses where they will perform better and to group together in a course similar performing students. This should lead to having more coherent audience within a course. Of course, all systems based on “popularity” can have unwanted side effects – flooding courses that are most popular or where it is easier to receive a better grade. This is why these recommendations are not the only ones given to the students. We also employ static lists of course recommendations based on the specializations that students want to achieve. We have created profiles, which link together group of courses relevant to a specialization. Such course sequences are manually selected, and are offered to the students as prime priorities, side-by-side to the computed social-based recommendations.

4. CONCLUSION AND FUTURE WORK

Unfortunately, all these developments only help when the student has a free choice, and as we have seen the main problem students have is with mandatory courses leading to a certain degree and courses with complex prerequisites and dependencies. And despite mentioned technical innovations, the process is yet not fully personalized. The first implementation of the system used only simple indicators of various performance factors and only in their absolute form (average length of the studying overall, average percentage of students having to re-enroll a course no matter the time period, whether the course belongs to a certain module or whether it is mandatory). The students’ applications were processed automatically without getting into details about personal requests. The second implementation and introduction of recommendation engine, gives more statistical tools at the hands of the students, increasing their responsibility of a smart decision. While making the process of choice easier it still does not model the full context of each students interests and his academic performance. Introduction of various data-mining algorithms for course recommendations relevant to the student (such as discussed in Romero and Ventura, 2010, and Aher and Lobo, 2012) and that are based on historical data on enrollments, in our view helps mostly students as groups, and not individually.

Usually, the methods in use discover clusters of students with similar relations and recommend courses either based on ratings given by students within the group (popularity), based on average grades
(achievement), based on sheer number of enrollments or even a combination of all such factors. A true personal and committed academic adviser should be able to discuss and understand the real requirements of the student and his wishes, and not just numerical measures, and should propose an entire study plan that is best suited to the students interests in more general terms. We should strive towards such a virtual adviser system. Of course, it can not be expected that there is a system which will propose an ideal study plan for all cases and a direct propelling system into a star career. Such a system can not exist. The request is that we make a better system that takes into account in more details personal factors relevant to the student and steer towards the choices that are more suitable for his case.

The idea is that both academic performance and personal interests of students per knowledge areas have to be taken into account in order to get a more realistic model of each student and give better recommendations. This should be done in a systematic way, along with the following of curriculum design guidelines. So, unlike previous efforts, that are treating a course as a product and looking into ratings and occurrences, we should stop treating courses as atoms, but break them apart into constitution elements – such as subject topics and analyze details student behavior and achievement and correlate with planned learning units, goals, disciplines proposed in curricula recommendations developed by ACM, IEEE, AIS and other leading professional and scientific communities. In the ACM Curricula Recommendations, many aspects that should be taken care of in the process of curriculum design are presented. This knowledge base, can be used as a model on which to establish a recommendation system that takes into account fine grained details of how study programs, disciplines, knowledge areas, goals and objectives are interrelated. Some of the aspects that are considered:

- knowledge areas and topics
- learning units and goals
- course descriptions
- working disciplines and skills
- mapping between various elements from this list

Our current work is to use the same set of aspects to:

- track the realization of the curriculum in accordance to guidelines
- track students' success to elementary learning units and goals
- model the student user profile - interests and wishes based on specializations, disciplines and skills

This would enable to create a map between the academic performance of students and their fine grained interests, Combined with historic data on previous results from student course work (in a social aspect) this would enable a truly relevant personal advice. Examples of analytic findings, that are interesting for future discussion and that could be computed to give each student better recommendations and a more streamline study process towards personal career goals, are:

- find disciplines that build on skills tested with best results in a set of seemingly unrelated courses
- enroll courses where relevant skill-sets are more prominent in course-work
- choose study programs and setup study plans relevant to the specialization and a choice of courses
- find groups of class-mates that could achieve best results in certain future in-course projects and base recommendations on such findings

REFERENCES

Aher S. and Lobo L., 2012, Applicability of Data Mining Algorithms for Recommendation System in E-Learning, ICACCI ’12, CHENNAI, India, pp 1034-1040, ACM 978-1-4503-1196-0/12/08
Easyrec - http://easyrec.org/
ICT: THE STONE GUEST IN THE IMPLEMENTATION OF PERFORMANCE MANAGEMENT SYSTEM.
THE CASE OF ITALIAN ARMY

Armando Suppa¹, Alessandro Zardini¹, Cecilia Rossignoli¹ and Marco De Marco²
¹University of Verona - Via dell’Artigliere, 19 – 37129 Verona (Italy)
²University G. Marconi (Rome) - Via Plinio, 44 – 00193 Roma (Italy)

ABSTRACT
The Italian Public Administrations during the last years were involved in a long term-process of reform to “reinvent” the public sector in accordance with the New Public Management (NPM) principles. The last change was realized with the law 150/2009 that introduced the “performance” cycle in the Italian public sector. The Italian Army is involved in this changing process, as well as the other public organizations, by implementing a performance management system (PMS). ICT, another “megatrend” of NPM, which plays an invaluable role in this process, is the “stone guest” of a performance management system. In fact an “unresponsive” information system can be the Achilles’s heel of PMS. This article aims to respond to the following question: How could ICT contribute to the implementation of effective PMS in the Italian Army? The article is a work in progress.

KEYWORDS
Multidimensional Performance Measurement System (MPMS), Performance Management System (PMS), New Public Management (NPM), Case Study.

1. INTRODUCTION
In the last decades the public sector of the major developed countries was involved in a long-term process of reform following the New Public Management ideas (Pollitt and Bouckaert, 2000, 2011), that prescript to “reinvent” the government, an entrepreneurial government, more efficient and effective, through the focus on output/outcomes, downsizing, less bureaucratic, decentralized, in which the competition was promoted intra-organizations and inter-organizations. One of the main issues of this new approach is the citizen, that becomes a Government’s client, and as such, is redefined as customer whose satisfaction is the main issue (Osborne and Gaebler, 1992). The public administrations have to be more accountability to community’s needs by offering “value for money, choice flexibility, and transparency” (Melo et al, 2010). Similarly, the Italian Public Administrations were involved in this “reinventing” process (Dameri et al., 2012; Sorrentino, 2007). Several laws were issued (e.g. law n. 142/1990, law n. 59/1997, law n. 286/1999, law n. 150/2009 and law n. 189/2009) to change the traditional military-bureaucratic structure, based on orderly hierarchies and elimination of duplication (Ostrom, 1974), to a more managerial one. In other words, entrepreneurial organization, in order to “do more with less” (Osborne, 1993). The last of such reform was the law n. 150/2009. It introduced in the Italian public sector the performance and in particular the performance management cycle. The implementation of performance measurement and performance management are “the most widespread internationals trends in public management” (Pollitt, 2005). Performance is a multi-dimensional concept with a broad range of facets (Jackson, 1993; Kloot and Martin, 2000; Brignall and Ballantine, 1996). In this context, all Italian Public Administrations have to change their structure in order to be coherent to the law n. 150/2009 by the end of 2010. Hence, the Italian Army, as a part of the Ministry of Defense, immediately acted to develop and implement a PMS. Therefore the Italian Army is introducing a PMS composed by output based measurement system (using goal question metrics framework), what if analysis system, and integrated strategic financial model. Therefore, these three elements allow having a PMS that is a multi dimensional performance measurement system (Kaplan and Norton, 1992) and strategic
management system (Kaplan and Norton, 1996). In fact, the integration of the previews systems permits
obtaining a strategic management tool that ties the strategic corporate objectives with the operation goals.
Moreover, the reform process requests to the Italian Army to rewrite its processes, to introduce new ones –
performance planning, performance monitoring, performance reporting – and to integrate the processes
across different functions. The introduction of PMS requests to set and put in place technology in order to
support the new information architecture. In this respect, information technology (IT) plays a critical role
“determining the hardware, software and telecommunication technology a company needs to generate its new
measurement information is the second activity in the performance revolution” (Eccles, 1991; p. 135).
Bringall and Ballantine (1996; p. 24) argued that “an effective IT/IS is vital of the success of a type” of PMS,
a strategic management system, that is part of a feedback and learning process (Casalino, 2009) and enables
the strategic learning, therefore the organizational learning. The purpose of the present research is to
underpin the role of ICT in the introduction of PMS in the Italian Army: How could ICT contribute to the
implementation of effective Performance Management System in the Italian Army?

The article is structured as follows. The first section points out the theoretical background, which refers to
have a better understanding of the process enquired. The second section highlights the research propositions
and the next section provides features of research method and sample. Finally, the last one presents the
potential contribution of the study.

2. THEORETICAL BACKGROUND

The NPM “Paradigm” was the principal driver of the last Italian public administrations reforms. The NPM,
considering the weberian bureaucratic public organizations obsolete, proposed to introduce in the public
administrations successful innovation practices of profit-driven organizations such as: strategic management;
performance measurement, performance evaluation, personnel management etc. It is an “intra-organizational
program of administrative reform” (Peters and Pierre, 1998). The aim is to transform the public sector
through organizational changes, in order to improve public outcomes in terms of efficiency, effectiveness and
quality of service (Osborne and Gaebler, 1992). The law 150/2009 introduced one of its pillars, the
performance and its evaluation (Aucoin, 1990; Osborne and Gaebler, 1992). It is a very tough task to give an
univocal definition of public sector performance, which has different meaning for different groups (Jackson,
1993). In order to give a definition of performance, it is essential to identify the organization stakeholders, in
the sense of performance deliverables, to understand their priorities and expectation in order to achieve their
satisfaction efficiently and effectively, “Who are our stakeholder and what do they want from us?” (Neely et
al., 1995; 2001). Moreover there is no one unique performance indicator, but a “battery of indicators is
needed” (Jackson, 1993). These indicators, expressing different stockholders’ needs, could be in conflict, and
so, it is required to trade off and to balance the competing interests of stakeholders in setting the indicators
and related objectives (Jackson, 1993; Atkinson and Mc Crindell, 1997). The MPMS is a process of
“evaluating how well organizations are managed and the value they deliver to their customers” (Moulin,
2002; p. 188) using different perspectives of total performance. The PMS, as Lebas (1995; p. 34) proposed,
“involves training, team work, dialogue, attitudes, shared vision, employee involvement, multicompetence,
etc.”. The Italian Army introduced a PMS composed by an output based measurement system through goal
question metrics (Sarcia, 2010), a what if analysis, and an integrated strategic-financial model. In particular,
the PMS and the ICT are used in order to increase the coordination among different functions and integrate
their processes (Malone et al., 1987), increasing the velocity and quality of the information that feed the
decision making process and so decreasing the “decision information cost” (Gurbaxani and Whang, 1991).

3. METHODOLOGY AND DATA

In this paper will be adopted the exploratory case study research method (Stake, 1978, 2000; Creswell, 2007)
to analysis the phenomenon in its natural setting (Benbasat, 1984). The method of case study can be very
useful to have a better and clearly view of the introduction of new information technology and the relate
organizational change. The unit of study will be the Italian Army, during the implementation of PMS that
could last at least one year. We will collect data about Italian Army PMS by using qualitative data collection
techniques (Agar, 1980; Barley, 1990; Van Maanene, 1979). We started our collaboration with Italian Army after previous direct contact and some meetings with the officials in charge of the management accounting office. We will obtain data by documental and field analysis and several semi-structured interviews will be employed to investigate the phenomenon with staffs and managers involved in the performance management processes. The full access to organization’s respondents has facilitated the process of data collection from several sources, which has increased the quality of the data obtained (Eisenhardt, 1989). Transcripts and research draft resulting from data collection were submitted to the attention of key-informants in order to receive a validation of the observations obtained. Their suggestions and insights were then considered in the process of data analysis. Furthermore, we used Atlas.ti, a qualitative data analysis software, that helped us in the content analysis (Miles and Huberman, 1994). Data collection started in June 2010 and lasted approximately eight months. Data analysis and integration of extant data took place in the first half of 2012.

4. FIELD STUDY

The Italian Army is a really complex and hierarchy organization which is composed of about 500 spending sub-organizations. There are more than 100000 employees and last year the Italian government invested approximately 0.90% of GDP. Last years the IA has been interested on a profound transformation that it has reduced its strength from the previous 300.000 units to the actual 107.000 (all volunteer soldiers), on the other hand, the involvement in peace support operations it has increased. Moreover, since 2004 the national financial situation has imposed relevant limitations to the annual budget for the defense function. The Italian Army appropriation for the operation cost dropped by 70% in the last nine years from € 1.028.000 in 2004 to € 310 million in 2012. In the 2009, the IA started the study, development and adoption of a PMS. In consideration of the foregoing, it is possible to verify how important it is for the IA to manage the funds assigned in the more possible efficient and effective way, avoiding waste and cost duplications in order to obtain the higher possible performance, in consideration of budget constraints.

4.1 PMS Introduction

The Italian Army is introducing a PMS either to conform to the law n. 150/2009 requirements either to improve its efficiency and effectiveness. Both reasons are generated by the same issue to deliver the same performance level with less money due to cuts in public budget and difficulty to financing institutional activities exclusively with public funds. Indeed according to Italian Army Chief of General Staff: “The current economic situation has forced a significant acceleration in the direction of improving the quality and efficiency of public spending... in order to achieve, through a clear definition of trinomial objectives, resources and accountability, expense rationalization and the elimination/reduction of waste” (Army General Staff, 2010; p. 9). In essence the Italian Army has the necessity to handle and assessing its multidimensional performance. It needs a strategic management system that is a holistic model, that enables to plan, monitor, measure (Casalino et al., 2008), evaluate and align throughout the organization the performance balanced among different dimensions. According to Di Paolo’s model (2007), it will be a good idea to match PMS with a predictive model of “What if Analysis” in order to evaluate the “productive capacity” (and performance) of Italian army compared to the annual assigned funds. The What if Analysis is embedded in the performance management system and allows to operate some decisional simulations in real-time on the individual tasks or processes. Moreover, it provides performance rates, which are obtainable by the whole organization for each volume of allocated resources. The system permits also to do some drill-down operations, in order to obtain a specific What if Analysis for each sector, function, or area. This process allows defining an activity of benchmarking, that could identify the objective target for each area of interest. The model is also able to establish the “boundary point” behind which the allocated funds result to be insufficient to carry out that activity, process or service. This rate should be check for every targets because if the evaluate value was below this threshold, the implied activity (or services) could not be executed. Since 2010 Italian army has introduced an integrated cycle of strategic-financial planning inside the PMS. This cycle has allowed to make some estimation and has provided to assign to them the relating financial resources. That integrated planning process involves the whole organization at its different hierarchy levels. During this first phase, the strategic planning is developed with the assignment of the objectives through a
top-down process. The main board executive organism, once it has received that indications, identifies some more specific objectives that are communicated to the lower hierarchy level and ad so till the level of the final executive organism. During this phase, the different representatives must also provide to formulate and indicate the objective value (obtainable result if the activity was completely funded), the target value (the obtainable result whit the assigned resources) and the time frame, metrics and indicators for the objectives’ achievement. Once the strategic planning has been ended, the second step of the integrated strategic-financial planning begins. During this step, the strategic planning is integrated with the financial planning, this last one, on the contrary of the strategic planning is made through a bottom-up process. In this way, the objectives determined during the strategic planning can receive the needed resources. Hence, only the activities that are relevant for the achievement of the strategic objective of the Italian army are funded, avoiding in this way the risk to allocate resources to activities that have not a “strategic” impact for the army.

The IA adopts two different “modules” for the Strategic planning/control, SIAPS+, and for the financial planning, SIEFIN. The SIAPS+ is an advanced IT solution that allows supporting integrated strategic and financial planning activities through a top-down approach. This system manages all processes (planning, budgeting, monitoring) from the top of the Organization (Army General Staff) to the operational units (regiments/battalion). Moreover, it creates specific dashboards for each level of the hierarchy, in order to have relevant monitoring, measuring and reporting activities. The last step was the implementation of a simpler method for defining and monitoring of targets, which is precisely the Goal Question Metrics method (Sarcia, 2010). In particular, the top managers of the internal management control office (UCIG) after the implementation of the Goal Question Metric into the PMS, they decided to develop and calculate a synthetic indicator in order to measure the managerial efficiency. Using this value, it was possible to formalize a forecasting model of "what-if Analysis", able to operate in real-time decision of the simulations, providing in output, for each volume of resources allocated, the percentage of the performance attainable by the whole organization.

5. CONCLUSION

The purpose of this research is to underpin, through analysis of data from documents, focus groups and interviews, how a performance management system, therefore ICT, can contribute to make a multi-facets, multi-objectives and multi-layers organization, such as Italian Army, more efficient and effective, and in that way to do more with less. There are several key factors that can drive to a successful introduction of a PMS, such as good communication throughout organizations; motivation and commitment, employee empowerment, organization alignment, identification and managing the organization performance drivers.

In this context, ICT plays a crucial role by permitting to process relevant information “in a more cost effective way”, supporting the decision making processes by increasing its speed and quality, and at the same time providing “the ability to improve monitoring and performance measurement, reducing agency cost” (Gurbaxani and Whang, 1991; p. 69). In fact ICT is a powerful mean in supporting “efficient auditing and control techniques” (Gurbaxani and Whang, 1991; Williamson, O.E., 1981). The factors underlined in this article could be useful in the analysis of similar cases, the implementation of a PMS, into a Central Public Administrations, based on bureaucratic structure. It is quite evident that this study needs further and deeper investigations in order to give a more incisive contribute in the understanding of the impact of PMS on the organization context in the public.

ACKNOWLEDGEMENT

We benefited from the collaboration and assistance of Italian Army General Staff and particularly of Army General Staff Control Office.
REFERENCES


Ostrom, V., 1974. The intellectual crisis in American Public Administration, University of Alabama Press, Alabama, USA.
INVESTIGATING THE DIRECT EFFECT OF INTRINSIC MOTIVATION ON LEARNERS’ BEHAVIOURAL INTENTION

Abdullah Al-Aulamie, Ali Mansour and Herbert Daly
Department of Computer Science and Technology - University of Bedfordshire
Park Square, Luton, Bedfordshire, LU1 3JU, UK

ABSTRACT
E-learning has shifted the learning paradigm from teacher-centered to learner-centered. However, one of the main challenges facing contemporary universities today is the low adoption of e-learning systems. In this study, we investigate the effect of intrinsic motivation factors on learners' behavioural intention-to-use a web-based learning system such as the Blackboard, by extending the Technology Acceptance Model (TAM).

KEYWORDS
Enjoyment, Computer playfulness, Technology Acceptance Model, E-learning

1. INTRODUCTION
E-learning refers to the use of electronic channel to deliver information or knowledge to users beyond time and space restrictions (Sun et al., 2008). Since the early 1950's, e-learning has been used in education and it was referred to as distance learning (Clark, 2000). The term e-learning also includes web-based learning, online learning, technology based learning, networked learning (Alenezi, 2010). E-learning has shifted the learning paradigm from teacher-centered to learner-centered. By enabling higher educational institutions to expand their educational services online and enhance their traditional teaching methods. The web-based learning systems (WLS) enable students to an easy access of information. Moreover, WLS can improve students’ performance, develop their learning experience, and enhance their computer self-efficacy (Saade et al., 2009). However, there is an increasing evidence that e-learning is being underused (Hsia, 2007), and one of the main challenges facing contemporary universities today, is the low adoption of e-learning systems (Tseng & Hsia, 2008). Therefore, designers and institutions should find proper solutions to support and encourage students to be more active and engaging with the web-based learning systems.

Since the development of the technology acceptance model (TAM) by Davis (1989), a large body of publications used TAM to investigate individuals' acceptance, adoption and intention-to-use various technologies but still there are a relatively few studies investigated the web based learning domain. Furthermore, Saade et al., (2007) confirmed the viability of TAM to explain learners' acceptance/intention-to-use web-based learning systems. In general, TAM focuses on the functional and extrinsic motivational drivers though these drivers might not be dominant in the WLS context (Agarwal & Karahanna, 2000). Lee et al., (2009) pointed at the importance of intrinsic motivation factors and their inclusion in the IT adoption. This study contributes to the technology acceptance literature by investigating the effect of two intrinsic motivation factors, enjoyment and computer playfulness on learners' behavioural intention-to-use WLS. We propose an extension of the technology acceptance model which will be tested in the web-based learning domain by focusing on intrinsic motivation factors.
2. TECHNOLOGY ACCEPTANCE MODEL (TAM)

The Technology Acceptance Model (TAM) was proposed by Davis (1989) to predict the individual adoption and the use of information technology. According to TAM, there are two beliefs that determine the individual's behavioural intention-to-use (BI) a technology; (1) perceived usefulness (PU) which is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance”, and (2) perceived ease of use (PEU) which is defined as “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989). Moreover, the technology acceptance model has been empirically validated over the last two decades (Mathieson, 1991; Moon & Kim, 2001; Taylor & Todd, 1995; Venkatesh, 2000; Hsia, 2007; Tseng & Hsia, 2008; Liu et al., 2010).

TAM is concerned with the system characteristics that will influence an individual to accept information technology. In TAM, subjective norms construct was removed from TRA and replaced by two factors, perceived usefulness and perceived ease of use. The theory suggests that perceived usefulness have a direct effect on attitude and behavioural intention while, perceived ease of use effect is on perceived usefulness and attitude. TAM suggests that attitude is the key factor in determining the user's behavioural intention and usage however, attitude was excluded from the final model because (Davis et al., 1989): First, the relationship between perceived usefulness and behavioural intention is more significant than the relationship between attitude and behavioural intention. Second, attitude is not able to fully mediate perceived ease of use effect toward behavioural intention.

3. INTRINSIC MOTIVATION

For a human to perform a specific behaviour or action, he/she must be motivated. Motivation considered being an important factor in determining individuals’ behaviour and action (Lin, 2007). Moreover, motivation can be classified into extrinsic and intrinsic. Extrinsic motivation refers to “the performance of an activity because it leads to instrumental rewards” (Saade et al., 2009), while Intrinsic motivation refers to the “engagement motivated by pleasure or enjoyment” (Henderlong & Lepper, 2002). Intrinsic motivation factors have shown significant results towards individuals' behavioural intention. For example, Alenezi et al., (2010) investigated students' behavioural intention-to-use e-learning. The authors extended TAM to include enjoyment as an intrinsic motivation factor. The results indicated that both of TAM constructs, perceived usefulness and perceived ease of use, and enjoyment have a significant direct impact on students' behavioural intention. Saadé et al., (2008), conducted a cross-cultural study to examine the role of intrinsic motivation on the acceptance of web-based learning by using TAM. The authors used participants from Canada and China and the research finding showed that intrinsic motivation played an important role in explaining students’ acceptance in both countries of the web-based learning system. However, perceived ease of use was significant only for the Chinese students because of the longterm of internet use and experience between the two groups. Lee et al., (2005) proposed an extension of TAM to capture the effect of intrinsic motivation (perceived enjoyment) and extrinsic motivation (perceived usefulness and perceived ease of use). The study used an Internet-based learning medium to test the proposed model, using a number of 544 undergraduate students. The results showed an equal strong impact from intrinsic and extrinsic motivators on the students’ attitude and intention-to-use the internet-based learning medium.

4. RESEARCH MODEL

This research will examine the effect of intrinsic motivation on students' behavioral intention-to-use a web-based learning system such as Blackboard. The technology acceptance model was extended, Figure 1, by adding two intrinsic motivation factors; enjoyment and computer playfulness. Computer playfulness refers to “the degree of cognitive spontaneity in microcomputer interaction” (Webster & Martocchio, 1992). Roca and Gagné (2008) point out the significance of computer playfulness to determinate individuals’ intention-to-use and actual usage of information technology. Moreover, most of the intrinsic motivators of to adopt a system are hedonic features, such as playfulness, enjoyment and happiness (Venkatesh & Brown 2001). Based on
that, we hypothesised the following: H1: Computer playfulness will have a positive effect on learners' behavioural intention-to-use the Blackboard.

Enjoyment refers to “the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use” (Venkatesh, 2000). Enjoyment will explain a significant variance in the individuals' intention-to-use (Davis et al., 1992 cited in Moon & Kim, 2001). Still, few studies investigated the following: the effect of enjoyment in the e-learning context and the effect of enjoyment and computer playfulness together on learners’ acceptance and intention-to-use of web-based learning systems (Venkatesh & Bala, 2008). Therefore, we hypothesised the following: H2: Enjoyment will have a positive effect on learners' behavioural intention-to-use Blackboard.

Based on the technology acceptance model (Davis 1989), perceived usefulness (PU) and perceived ease of use (PEU) are considered to be the main drivers for behavioural intention (BI) a specific information technology, therefore we further hypothesised the following: H3: Perceived usefulness will have a positive effect on learners' behavioural intention-to-use the Blackboard. H4: Perceived ease of use will have a positive effect on learners' behavioural intention-to-use the Blackboard.

5. METHODOLOGY

To test the research hypotheses, a questionnaire tool was developed and validated using a pilot study, based on the pilot study results some corrections were made to the questionnaire. The scale items used to examine the proposed model were adapted from literature and they were modified to fit the context of this research (Davis, 1993; Sun et al., 2008; Shun et al., 2008; Venkatesh & Bala, 2008; Lee et al., 2009; Sanchez & Hueros, 2010). Moreover, the questionnaire was designed to have a five points multi-item Likert scale with "Strongly disagree = 1" and "Strongly agree = 5". The test subjects were full time undergraduate and postgraduate students at the University of Bedfordshire. All of the participants were familiar with web-based learning system (Blackboard) as they have been using it during their academic study. The questionnaire was handed to students in the class rooms, a total number of 54 responses were collected and only 51 responses were used due to missing data in 3 questionnaires.

6. DATA ANALYSIS

To test the construct validity, a confirmatory factor analysis was conducted by dividing the model constructs into two groups due to the small sample size (Coakes and Steed, 2003). The first group was for perceived usefulness, perceived ease of use, and behavioural intention, and the second group was to for enjoyment and computer playfulness. From the confirmatory factor analysis, three factors emerged from the first group and two factors emerged from the second group, factor loading for all variables were greater than 0.60, Table 1 and Table 2, and no cross-constructs loading above 0.50, indicating good discriminant validity. Moreover, for the internal consistency, Cronbach Alpha was used. All of the variables had a good reliability, a minimum of 0.70 and above.
7. HYPOTHESIS TESTING

The research hypotheses (H1-H4) were tested using a multiple regression analysis. The results showed that only three of the four hypotheses were supported. The Standardized coefficients and level of significant for the supported hypotheses were, Figure 2, computer playfulness ($\beta=0.27, p<0.05$), enjoyment ($\beta=0.26, p<0.1$) and perceived usefulness ($\beta=0.28, p<0.05$). Hypotheses H1 and H3 were supported with a high level of significance, ($p<0.05$). Moreover, hypothesis H2 was also supported however, with a lower significance level, ($p<0.1$). Finally, perceived ease of use did not post any significance towards behavioural intention thus, hypothesis H4 was rejected.

![Figure 2. Hypothesis testing](image)

8. CONCLUSION

The study showed that intrinsic motivation has a positive effect on learners' behavioural intention-to-use web-based learning system such as the Blackboard. The result suggests that, enjoyment and computer playfulness are significant in determining learner's behavioural intention. Moreover, the relationship between
perceived usefulness and behavioural intention is consistent with the previous studies of TAM. The inconsistency between perceived ease of use and behavioural intention has been one of TAM limitations (Davis et al., 1992; Chau, 1996; Szajna, 1996; Chau & Hu, 2001). The reason for this inconsistency may possibly be due to system complexity variance, users' experience and gender (Surbamanian, 1994; Venkatesh & Morris 2000). In this research, we investigated the effect of intrinsic motivation factors on learners' behavioural intention-to-use web-based learning system, e.g. Blackboard, by extending the Technology Acceptance Model. The preliminary result showed a significant relationship between intrinsic motivation and learners' behavioral intention. However, there are some limitations that should be noted. First, caution need to be taken in generalizing the study results due to the small sample size. Second, the proposed model did not account for any moderating effects such as users' experience, gender and age, which need to be considered in future research in the e-learning context. Therefore the proposed model will be further tested to account for the moderating factors and by using a larger sample size.

REFERENCES


Liu, I. F. et al., 2010. Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community. Computers & Education, Vol.54, No.2, pp. 600-610.


Reflection Papers
EVALUATION BY USING THE INFORMATION SYSTEM SUCCESS MODEL

Asc Prof (FH) Mag (FH) Hans-Peter Steinbacher
University of Applied Sciences Kufstein
Andreas Hofer Str. 7, 6330 Kufstein, Austria

ABSTRACT
The innovation process in small and medium sized companies is still insufficient supported by IT tools. Therefore the software “Tech IT Easy” (TIE) was designed which allows structured, guided and still dynamic IT support in the process of innovation. This paper describes the results of the evaluation process of the software by using the information system success model and gives a brief overview of the usage of the methodology that is used as well as the summarized results of the evaluation and further research.

KEYWORDS
TRIZ, innovation process, information system success model, ISSM

1. INTRODUCTION
Companies have to deal with the rapidly changing requirements in their daily business. A common way to solve this issue is adapting their business processes. But well-worn processes and inflexible information systems hinder a reaction on the external factors in time. This is not only for main business processes but also for knowledge-intensive processes like the process of innovation in a company. Especially small and medium sized enterprises (SME) do not have enough resources and knowledge to adapt their knowledge management processes to the business changes. They are missing support in the high dynamical and complex processes, centralized management of all knowledge intensive information as well as decision support tools for the responsible employees in the innovation departments.

The above mentioned and even more issues concerning the topic of innovation processes in SME have been investigated in the project “Tech-It-Easy” (TIE) which was supported by the FP7 of the European commission in the program “Research for the SME’s”. In this project a software toolset has been developed which is based on a methodology for structured innovation management. This tool set is covered by a framework which allows the interaction between the different tools by e.g. providing the same data input for different tools within the framework. Different tools for the structured innovation process have been implemented into the toolset e.g. the Theory of Inventive Problem Solving (TRIZ) developed by Altshuller 1999, House of Quality (King B. 1989).

So this software supports a guided but still dynamical approach to manage the innovation processes in SME. Different tools care about the innovation process and allow to work easy, guided and fast through the different phases of the innovation process. Additionally ontologies and semantic web support the management of the relevant information.

2. METHODOLOGY
To test the reliability and benefit of the developed framework including the software tools an important part in the project has been the software evaluation which was an approach with two phases. In phase 1 the was done a be tested with labour conditions and in phase 2 the evaluation was carried out by using the “Information System Success Model” (ISSM) (figure 1).
The ISSM (DeLoan and McLean 2003, Petter 2011) – is based on the Technology Acceptance Model (TAM) and can be described as below: The arrows demonstrate proposed associations between the different success dimensions.

![ISSM Diagram](image)

Figure 1. ISSM (source: DeLoan and McLean 2003)

The system can be evaluated in terms of information, service, and system quality and these characteristics affect the following uses or intention to use/use and also user satisfaction. By using the system, certain benefits will be achieved. The so called net benefits will influence user satisfaction and the further use of the information system, positively or negatively. This general approach and extensive view on an information system leads to the use of the ISSM in this research project.

The main part of the evaluation included the implementation of the ISSM fitting to the requirements of the knowledge management domain. As a result the items of the six dimensions have been expanded into categories they belong to the knowledge management domain. (Table 1 shows an extract of categories of the ISSM dimensions). The categories and out of it the more grained issues have been found by literature research (Collopy 1996, Doll 1994, Ives 1983). On the level of the issues the questionnaire has been designed. After the software test phase the customers filled in the questionnaire (Likert scale) and were also invited for an additional guided interview for the qualitative feedback. Descriptive statistic was used to analyse the results of the questionnaire and qualitative methods for the interviews (4 participating SMEs with each 3 persons responsible for the innovation processes attending).
Table 1. Categories of ISSM dimension

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - System quality</td>
<td>A1 - system technique</td>
</tr>
<tr>
<td></td>
<td>A2 - efficiency of system</td>
</tr>
<tr>
<td></td>
<td>A3 - support of system</td>
</tr>
<tr>
<td></td>
<td>A4 - straight forwardness of system</td>
</tr>
<tr>
<td>B - Information quality</td>
<td>B1 - usability of information</td>
</tr>
<tr>
<td></td>
<td>B2 - adaption of information</td>
</tr>
<tr>
<td></td>
<td>B3 - completeness of information</td>
</tr>
<tr>
<td></td>
<td>B4 - validity of information</td>
</tr>
<tr>
<td></td>
<td>B5 - intelligible information</td>
</tr>
<tr>
<td>C - Service quality</td>
<td>C1 - competence of IT</td>
</tr>
<tr>
<td></td>
<td>C2 - quality of training</td>
</tr>
<tr>
<td>D - Intention to use/use</td>
<td>D1 - motivation of system use</td>
</tr>
<tr>
<td>E - User satisfaction</td>
<td>E1 - satisfaction of whole system</td>
</tr>
<tr>
<td>F - Net benefits</td>
<td>F1 - internal communication</td>
</tr>
<tr>
<td></td>
<td>F2 - quality of decisions</td>
</tr>
<tr>
<td></td>
<td>F3 - external collaboration</td>
</tr>
<tr>
<td></td>
<td>F4 - Service equality</td>
</tr>
<tr>
<td></td>
<td>F5 - process quality</td>
</tr>
<tr>
<td></td>
<td>F6 - strategically use</td>
</tr>
</tbody>
</table>

3. RESULTS

The lab test (phase 1) supported the final release candidate of the software by eliminating functional defects. The most important part, regarding useful feedback, was based on the ISSM by analysing the investigation of the six dimensions in the ISSM and their issues.

In the dimension of system quality the question of easy usage of the software was highest rated by a mean of 1.5 which leads to the acceptance of the conceptual idea of the implemented software tool and framework. In the dimension of information quality all questions range between 2 and 3 only the question on “Without the software, innovation can’t be done” has been rated with a mean of 3.5. This shows that the implementing of such software doesn't benefit by an implementation with a big bang approach. It has to be a step-by-step procedure by full involvement of all concerning employees in the innovation department. The dimension service quality of the System got a rating mostly around 2. The point of training for the user of the software should be improved. The dimensions intention to use/use and user satisfaction are valued between 2 and 3, which leads to the assumption that further improvement in the user interface of the software tool is needed.

The general statement is that even when it supports party the process of innovation, the software is not totally assimilated in the formal innovation process of the SME’s. Even when the software itself was easy to use and raises user satisfaction, the benefit of the software increases by the full integration in the internal innovation process of the SME’s.

The general result of the interview supported the results of the quantitative analyses and gave good ideas for further improvement of the TIE software tool.

The ISSM was supporting the evaluation process by the useful structure of the evaluation model. The dimensions used to find relevant categories and issues in the knowledge management domain and therefore grant an effective built questionnaire. The dependencies mentioned in the ISSM are confirmed by the interpretation of qualitative questionnaire results and the quantitative results of the interview. Further work
can be invested in focusing on innovations management domain instead of the here chosen knowledge management domain, as there are fine grained differences expected. To bring the evaluation results to a more abstract level in sense of the knowledge management domain, a larger sample size would be needed for the reliability of the survey.

REFERENCES

USING THE FLOW MODEL TO INCREASE IT STAFF PRODUCTIVITY

Derek Smith
University of Cape Town - Rondebosch, Cape Town, South Africa

ABSTRACT
There is an ongoing need for IT professionals to be highly productive. A substantial body-of-knowledge already exists covering both motivation and turnover of IT professionals. Despite this, the quality and delivery of IT products and services remains an IT management problem. This reflection paper identifies the positive psychology field, and specifically the Flow model, as an area of research which might provide support to IT managers who are considering ways to enhance staff productivity and increase product quality.

The Flow model identifies 10 factors that are required to enhance IT staff productivity. These factors were compared with existing motivational research. It was concluded that 5 of these factors have already been well researched whilst the others have not. Further research is required to understand how all the 10 factors together could be applied to an IT professional to make maximum use of Flow.

KEYWORDS
Productivity, motivation, flow, IT professional

1. INTRODUCTION
To satisfy the ongoing requirement for increased delivery speeds of new technology products and services, Bartlett and Ghoshal (2002) claim that it will require highly skilled staff who are continuously motivated. They claim that this has not yet happened and staff are “more exhausted than empowered, more cynical than self-renewing”. In terms of productivity in Information Technology (IT) projects, De Marco and Lister (1999) argue that “the major problems of our work are not so much technological as sociological in nature.” High percentages of IT projects continue to fail despite improvements in the project management discipline and the move to agile development approaches. There are serious implications with these trends. In a recent book, Nobel prize winner Daniel Kahneman (2012) describes the extreme complexities of decision-making and problem-solving.

This reflection paper bases its arguments on the possibility that, in general, IT professionals are producing sub-optimal solutions to increasingly complex problems because they are not being managed correctly. It argues that IT management should place more emphasis on providing the optimum environment for complex problem-solving. Whilst IT staff motivation and turnover have been researched, applying the Flow model to increase IT professional productivity has not received attention. The concept and characteristics of Flow, developed by Cziksentmihalyi (1990), are presented as a possible approach to assist IT managers to improve both staff motivation and product quality. In particular, the flow model with its 10 factors are briefly compared and contrasted with current literature on IT staff productivity.

2. IT STAFF PRODUCTIVITY ISSUES
IT professionals are expensive and consume a large proportion of project budgets. It is therefore important to manage staff so they can produce quality work over extended periods of time. There is a considerable body of research on IT staff motivation covering both extrinsic and intrinsic motivation (Couger and Smith, 1992; Abuhandeh & Czikszentmihalyi, 2009) and IT staff turnover (Smith & Speight, 2006).
The job diagnostic survey (JDS) (Hackman & Oldham, 1976) has been researched extensively (Couger and Smith, 1992; Eisenberger et al., 2005) and provides guidance to IT management in terms of the importance of the 5 core job dimensions of skill variety, task identity, task significance, autonomy and feedback. These lead to the individual experiencing the 3 critical psychological states of meaningfulness of work, experienced responsibility for outcomes, and knowledge of the actual results of the work activities. This in turn helps to create the personal and work outcomes of high internal work motivation, high quality work performance, high satisfaction with the work, and low absenteeism and turnover. One of the measures from the JDS is Growth Needs Strength (a measure of the person’s drive for achievement). In the Couger and Smith (1992) study the overall GNS score for IT professionals, on a 7-point Likert scale, was 6.7. Couger previous research covering many countries had determined a similar high number which was higher than most other professional groups measured using the JDS.

In addition to staff being motivated to work, they must have a work environment conducive to work. The world of work consists of many diversions. For example, the open plan office found in many organisations is generally very disruptive. In addition, new technologies like cell phones, email, instant messaging and social networking applications can seriously disrupt “thinking time”. De Marco et al (1999) summarises this by claiming “we haven’t got time to think about this job, only to do it”.

3. IMPROVING IT STAFF PROBLEM-SOLVING

A vital competency of many IT knowledge workers is to engage in complex problem-solving. These problems tend to be abstract and conceptual requiring a “systems thinking” approach (Checkland et al, 2006). Effective problem-solving takes time and requires discipline. According to Kaheman (2011), “even in the absence of time pressure, maintaining a coherent train of thought requires discipline.” However, he argues that there is a limit to the effort an individual can put in even if it is enjoyable. IT management need to ensure that their staff are given every opportunity, including the space and time, to maximize their available effort to produce the best quality products. As Konnikova (2013) claims about the meditative approach used by the great Sherlock Holmes to solve mysteries: “Meditation is nothing more than the quiet distance that you need for integrative, imaginative, observant and mindful thought.”

4. THE CONCEPT OF FLOW

Csikszentmihályi (2003) defines flow as “completely focused motivation. It is a single-minded immersion and represents perhaps the ultimate in harnessing the emotions in the service of performing and learning. In Flow, the emotions are not just contained and channelled, but positive, energised, and aligned with the task at hand.” In his seminal work on Flow, Csikszentmihályi (1990) describes Flow as allowing a feeling of spontaneous joy while performing a task although flow has also been described as a deep focus on a current activity. Colloquial terms used to describe Flow include: to be on the ball, in the moment, present, in the zone, wired in, in the groove, or keeping your head in the game.

Csikszentmihályi (1993) identified ten factors that may be present in part or total when experiencing Flow. These are:

1. “Clear goals” (expectations and rules are discernible and goals are attainable and align appropriately with one's skill set and abilities). Moreover, the challenge level and skill level should both be high.
2. Concentrating, a high degree of concentration on a limited field of attention (a person engaged in the activity will have the opportunity to focus and to delve deeply into it).
3. A loss of the feeling of self-consciousness, the merging of action and awareness.
4. Distorted sense of time, one’s subjective experience of time is altered.
5. Direct and immediate feedback (successes and failures in the course of the activity are apparent, so that behavior can be adjusted as needed).
6. Balance between ability level and challenge (the activity is neither too easy nor too difficult).
7. A sense of personal control over the situation or activity.
8. The activity is intrinsically rewarding, so there is an effortlessness of action.
A lack of awareness of bodily needs (to the extent that one can reach a point of great hunger or fatigue without realizing it)

Absorption into the activity, narrowing of the focus of awareness down to the activity itself, action awareness merging.”

### 4.1 Aligning Flow with Motivation Theory

Csikszentmihályi’s (1993) ten factors have a strong correlation with prior research on motivation and productivity. However, some of the factors have not been widely researched for the IT professional.

The factors that relate to the JDS specifically include:

- **Clear goals** is both an important and common factor in previous research findings. Goal setting should be a shared, cooperative activity especially in IT teams (Smith et al, 2002). In addition, goals should be both challenging whilst attainable.

- Providing **Immediate feedback** when the activity is completed ensures the effort is rewarded when successful thus strengthening good practice or ensuring poor work performance is quickly identified leading to immediate improvement.

- Delegating work to team members so that there is a **Balance between their ability level and the job challenge**. Based on the individual’s competency, the work should be achievable yet challenging.

- A sense of **personal control** over the situation or activity. Tasks should be fully delegated to team members and they should be held accountable for outcomes.

- The activity should be **intrinsically rewarding**. The person should be motivated to complete the task and have a feeling of accomplishment (Couger & Smith, 1992). Eisenberger et al (2005) conclude that IT professional’s high need to achieve is correlated to a greater positive mood and performance.

The following 5 factors in the Flow model are unique:

- **Concentrating**, a high degree of focus and concentration on an activity should be feasible. The work environment and the management of the project team member should be conducive to allow high levels of focus. The daily Dilbert cartoons have covered the productivity issues of work cubicles and open-plan offices extensively.

- A **loss of the feeling of self-consciousness**, the merging of action and awareness. Whilst research on this factor in sport is well covered, specific research on IT professionals is lacking. This factor may be important when considered with Agile development methods like SCRUM where feedback mechanisms are short and regular (Feng, 2009).

- A **Distorted sense of time** where Flow occurs and the passion of doing the job is more important than the passing of time. This is possibly the key essence of Flow and needs to be researched further for IT professionals.

- A lack of awareness of bodily needs. The joy of the work should transcend time and physical needs.

- Absorption into the activity when Flow takes place leading to focus and involvement and a high quality outcome.

These last 5 Flow factors need further research in the context of IT professionals and their productivity.

The challenge for IT managers and IT project managers is to create the environment to maximise the number of flow experiences their staff have leading to the possibility of quality products and higher individual productivity.

### 5. CONCLUSION

There is increasing pressure on IT managers to deliver quality products faster. IT managers need to fully utilise their expensive staff by ensuring their IT staff are motivated and highly productive. A recent body-of-research from the Positive Psychology field that may have merit is that of Flow. This research described the ten factors of Flow identified by Csikszentmihályi (1993), and commented on how some of these overlap with previous research findings in motivation research for the IT professional. It appears that there is a lack of research with some of these factors.
Personally, I have experienced flow (see Appendix) and fully appreciate its power to promote motivation, quality and productivity. Further research is required to identify how the 10 Flow factors, but especially those 5 unique to the Flow model, can contribute to increased IT staff motivation and IT product quality.

REFERENCES


Czikszentmihalyi, M. 2009. The Promise of Positive Psychology, Psychological Topics, 18(2), 203-211.


APPENDIX - A PERSONAL EXPERIENCE OF FLOW

I had to set a final exam paper for a post-graduate class in 2010. My plan was to create a complex case study as a pre-exam handout and then set 10 exam questions covering the main course topics which students would have to answer relative to the case study.

I had spent time planning the format and the themes prior to heading to my office one Sunday afternoon. With no interruptions, no emails, no cell phone and a highly focussed objective, I set about the task. I made good progress and realised that, having almost completed the task, four hours had passed. I sent the various documents to the external examiner. I went home on a high with a strong feeling of accomplishment of something special. The next day, the external examiner commented that it was probably the “best” exam that he had ever reviewed. It appeared that I had had a flow experience (Nielsen & Cleal, 2010).
SUPPORTIVE ICT TOOLS IN AID OF INTERACTIVE POLICY-MAKING

Dóra Őri
ICT Doctoral School, Corvinus University of Budapest - Fővám tér 13-15, H-1093 Budapest, Hungary

ABSTRACT
The process and quality of policy-making affect the citizens at several points during the course of the execution. The inclusion of citizens is nowadays a focal point in policy-making, especially together with preliminary impact analysis. Current policy-making practice suffers from several problems which undermine the productive operation of the process. The concept of interactive policy-making is a significant step to broaden the inclusion of citizens, as well as to support preliminary impact analysis. The method can be promoted by several ICT tools and methodologies. In this paper the process of interactive policy-making is presented in a life cycle approach, together with the major supportive tools which can be used during the process. Major challenges concerning the concept are collected in order to draw attention to the questions necessary to answer.

KEYWORDS
Policy, policy-making, interactive policy-making, supportive ICT tools

1. INTRODUCTION
In the process of policy-making growing demand can be detected to reveal the opinion of stakeholders affected in the policy decisions, as well as to analyze the impacts of the policy decisions in advance. These aspects are considered crucial in order to improve the policy-making process. The concept of interactive policy-making pays respect to these aspects, namely serves the inclusion of the stakeholders affected in the decision-making process, and favours the preliminary impact analysis as well. Several ICT tools and methodologies can be applied to support the process of interactive policy-making. These tools and methodologies intensify the productive operation of the policy-making process as well as contribute to the implementation of the above mentioned intentions.

2. RESEARCH PROBLEM
The research problem being examined in this paper can be deduced from two aspects having an effect on each other and therefore creating the scope of the examined area. On one hand growing demand can be identified in terms of collaboration during the policy-making process. (Hajer and Wagenaar, 2003; Graaf and Michels, 2010) On the other hand current policy-making practice has its own limitations, in which the policy-making process runs according to its current rules and stipulations.

In the process of policy-making increasing need can be detected to improve collaboration among the stakeholders affected by the policy in question. (Papadopoulos and Warin, 2007) The concept aims in general terms collaboration at the highest level. However, what stakeholders in the process have to understand is that the rise in need is considered as fluctuating. The trend of this observation is referred to as a wavering movement, giving way to the rise of regional collaboration from time to time. (Wallace and Wallace, 1999) The limitations of policy-making are created by public policy. The most important aspect what has to be considered in terms of policy-making is the proportion of decisions to having a rule or a frame to observe. In case of having a frame to observe wider latitude can be practiced, giving broader interpretation opportunities concerning the implementation of the decision in question. However, rules create tighter sweep, distinctly
one and only, to fit the regulation or not. Even so, in case of rule creating implementation alternatives can be interpreted.

In the investigation space created by the above mentioned aspects two requirements are becoming increasingly emphatic and stressful. The inclusion of the stakeholders affected in the policy decision and the preliminary impact analysis of the policy decision. According to Sanderson, they constitute accentuated requirements during the policy-making process. (Sanderson, 2002).

3. CURRENT POLICY-MAKING PRACTICE

The process of policy-making can be referred to as a central topic in public policy. The term of policy-making means the course of decision-making in time, together with the strategic commitment and the implementation of a complex action program simultaneously. Policy-making is a complex decision-making process, which has fundamentally four stages: 1) initiation, 2) formulation, 3) implementation and 4) evaluation. Initiation stage includes the emergence of the issue, formulation means the formal decision-making, implementation implies in fact the go-to-practice of the decision, whereas the evaluation stage fulfills the analysis of the process outcomes. (Gyurgyák, 2004)

In terms of policy-making implementation there are some characteristic problems which can occur during the policy-making process. Typical difficulties regarding policy-making are a) trust (legitimacy) deficit (rooting from the lack of initiation), b) power deficit (because of indecisiveness and decisions of low effectiveness), c) social deficit (the confrontation between political power and society) or d) ideological hiatus (owing to the inability to realistic self-evaluation). (Gyurgyák, 2004)

Talking about the current policy-making practice, it can be stated that the process of policy-making suffers from several problems in its actual state. The major difficulties include the lack of information, failings in feedback utilization and the moderate usage of tools being supportive in preliminary impact analysis. One of the problems occurring in the current practice is the lack of information. Due to the lack of information preliminary impact analyses cannot be conducted in a satisfactory way. Therefore, policy makers do not know intimately the impacts the policy can exert. Without an appropriate deal of information preliminary impact analyses result in guessing failing to find proper evidences confirming the observations the analyses work on. (Sanderson, 2002) Another difficulty in the current state of policy-making is the moderate usage of supportive tools in conducting preliminary impact analyses. Without using such supportive tools preliminary impact analyses are vain, narrowing the opportunities these analyses could eventuate. Failings of feedback utilization result in unsatisfactory encapsulation of the policy-making process. Feedback coming from the citizens cannot be invoked in the process, if feedback utilization methods are not established. Without feedback reception and processing contributions coming from the citizens are vanishing. Feedback mechanism is essential from the point of view of closing the loop in policy-making process. (Moynihan and Wichowsky, 2008)

As a conclusion it can be stated that the main critical success factor of the decision- (policy-) making process is the handling of complexity in which extent the life-cycle approach is applied. In the following sections an appropriate ICT based concept, which reflects to the challenges, will be explained in detail.

4. INTERACTIVE POLICY-MAKING

The increasing need of citizens to articulate their opinion, the rising influence of social media and the requirement to analyze the impacts of the policy decisions in a preliminary way have launched the concept of interactive policy-making.

Interactive policy-making originates from the assumption that policy makers prefer utilizing the opinions coming from the citizens affected in the policy decision. Since citizens show perceptible interest in articulating their opinion concerning the issue in question, policy makers utilize this willingness in order to improve the quality of policy-making. Figure 1 shows a potential implementation of the interactive policy-making process. The concept presented in Figure 1 will be explained in detail in the following section.
The process of interactive policy-making is summarized as follows: As a first step the policy maker submits the initial measurement to a public debate in the form of a forum post. To raise public interest concerning the initial measurement social media is invoked in the process. Citizens publish their opinion regarding the measurement in the form of comments on the page of the post. The comments are firstly analyzed by text mining applications in order to explore latent coherences and to reveal topics touched in the discussion. By the help of the results derived from the text mining step domain ontology is built. According to the ontology nodes specific knowledge is placed on the page of the post coming from a knowledge repository. It helps citizens to broaden their domain knowledge concerning the topic in question. By means of the pieces of knowledge the quality of the comments can be improved and questions occurred during the debate can be cleared.

After publicly debating the initial measurement the comments are interpreted and processed. In this step complex event processing (CEP) methods are applied, as an implementation option to interpret comments. By complex event processing patterns and profiles can be formed, as well as rules can be created in order to manage joint occurrences. At this step the impacts of rules can be preliminary analyzed. According to CEP results statistical analyses are produced. By the help of statistical analyses keywords are analyzed to examine frequency of occurrence and distribution in time. In addition, commenters are analyzed concerning for instance the time they devote to discussion and the frequency they post a comment. The usage of knowledge repository is also analyzed, i.e. how many times commenters click to repository contents placed on the page of the post. By the same token, the correlation between the discussion and the knowledge fed back to the page is examined, i.e. how the knowledge placed on the page of the post infiltrates into the course of the discussion. Finally, critical success factors and key performance indicators are created in order to measure the discussion about the policy in question. At the end of the discussion processing step data visualization tools are available to visualize results and draw conclusions on the basis of the discussion processing outcomes. By help of data visualization module distributions are visualized graphically, opinion-centers are detected and examined dynamically (in time and/or geographical dimensions) as well as the distances between opinion-centers are analyzed. Data visualization module is also suitable for discussion topic analysis, i.e. to identify the topics of the discussion and to alter the course of the discussion if necessary.

After the discussion processing step the processed results are fed back to the policy maker. In this way the policy maker will be able to recognize the opinions of the affected citizens as well as to assess the preliminary impacts of the policy. Through this step new aspects are identified and previously unnoted coherences are revealed. The policy maker interprets the results coming from the interactive policy-making process and revises the initial measurement according to the feedbacks. The revised measurement exploits the opportunities provided by interactive policy-making process. It can be stated that it will apparently be closer to the affected citizens since the interests of the stakeholders are taken into consideration.
5. CHALLENGES

The process of interactive policy-making raises several issues which have to be managed in order to implement the concept auspiciously and to exploit all the opportunities included in the concept. To achieve these goals focusing on these questions is crucial. (Edelenbos, 1999) The challenges which have to be managed include difficulties concerning electronic identity management, personal rights and data protection on one hand. (Friedewald et al, 2009) But on the other hand there are some soft issues, among others the willingness of citizens to share their opinion and the motivation of them derived from cultural factors. Last but not least there are some challenges stemming from the process as a whole. The process of interactive policy-making raises the questions of completeness, integrity, and verification. These aspects have also to be taken into account in order to implement the concept prudentially and circumspectly.

The above mentioned challenges have to be taken into consideration during the interactive policy-making process. It can be said that without considering these questions the process cannot provide the opportunities mentioned above.

6. CONCLUSION

The concept showed in this paper supports policy-making in becoming more attentive to feedback coming from citizens. The process of interactive policy-making provides solutions to emerging societal and policy-related needs, among others the increasing demand for inclusion and the requirement of preliminary impact analysis. The implementation of interactive policy-making promotes policy makers in reducing the difficulties occurring in the current policy-making practice. The concept itself as well as the usage of available supportive tools can presumably result in a reasonable progress concerning policy-making.

ACKNOWLEDGEMENT

The financial support of TÁMOP 4.2.2/B-10/1-2010-0023 is gratefully acknowledged.

REFERENCES

REVOLUTIONS 20TH AND 21ST CENTURIES: ARTIFACT, IMPLEMENTATION, PROCESS

W. Brett McKenzie
Roger Williams University - One Old Ferry Rd, Bristol, RI 02809, USA

ABSTRACT
The 20th century saw dramatic changes in harnessing power, exemplified by the automobile. Similarly, the 21st century is seeing changes in harnessing information, exemplified by a myriad of devices that control, manage, and respond to data or information. This paper reflects on these revolutions in three dimensions: artifact, implementation, and process.

KEYWORDS
Techno-social change, Innovation, Technological discontinuity

1. INTRODUCTION

In 1900, Henry Adams stood in awe of the machinery at the International Exposition in Paris. In particular, he focused on “forces” most clearly embodied in the dynamo, producing electricity almost silently “…barely murmuring… it would not wake the baby lying close against its frame” (Adams, 1918). Adams distilled his experience to the virgin and the dynamo, making a parallel between the forces of the Church embodied in the Virgin, which organized Europe and subsequently the Americas through the 19th century, and the forces of the modern world, embodied in the dynamo, which would organize the coming 20th century.

While today’s events use contemporary broadcast technologies (Apple’s October 2012 iPad launch was live-streamed) to expand its audience and is consequently more virtual than the exposition in Paris one hundred years ago, the two events are parallel. They showcase the newest in technology, promise a different future, and outsiders are awestruck or confused by the meaning of the event.

This paper examines the digital revolution that will make the 21st century and compares it to the revolution that made the 20th century. It will contrast the two periods on three dimensions -- artifact, implementation, and process -- as summarized in Table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Artifact</th>
<th>Implementation</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>Automobile</td>
<td>Interstate Highway System</td>
<td>Factory</td>
</tr>
<tr>
<td>2000</td>
<td>Laptop Computer</td>
<td>Digital Network</td>
<td>Thermostat</td>
</tr>
</tbody>
</table>

Table 1. The two periods and respective objects of inquiry
2. COMPARATIVE REFLECTION

2.1 Artifact

Technological transitions create artifacts – objects or products and, more recently, practices – that embody and exemplify the changed world. Sometimes these artifacts are easily visible, such as the automobile. At other times they are more invisible and disappear into the new order, such as the electrical motor. In the modern kitchen, electric motors lurk in the refrigerator, the microwave, the coffeemaker, the blender and the exhaust fan, and in many other devices. Similarly, the digital revolution has spawned visible artifacts such as the computer, in forms from the mainframe through the desktop and now the tablet and smartphone. Likewise, there are the less visible manifestations in areas such as the communications networks, with their wires, fiber optic cables, switches and routers, and now even more invisible connectivity with towers and wireless communications.

The automobile is an easily examined artifact from the 20th century revolution because it is simple to trace its form and its effects on communities. Conceived in the late 1700s and developed first in the late 1880s, the gasoline powered internal combustion engine became the dominant form by 1910, despite attempts to use steam and electric as alternate power sources. In the 1920s the internal combustion engine peaked at its providing horsepower in the United States (Ausubel and Marchetti, 1966).

For the early 21st century, the laptop computer becomes the touchstone and comparative artifact. The computer was first conceived in the 1820s, then developed in the 1940s with ENIAC, and evolved to personal computers in the early eighties with the laptop entering in the late 1980s. The personal computer was a radical departure from the original mainframe or minicomputer because processing power was contained within the unit rather than managed through time-sharing from a remotely located computer. Similar to the automobile developing around the internal combustion engine, the laptop computer had standardized by 2006 on a model with a hinged screen, keyboard, and an internal architecture built on the x86 microprocessor design. The x86 microprocessor, like the internal combustion engine, has proved superior to the alternatives either in manufacture, ecosystem support, or potential.

Both these artifacts developed ecosystems around them. For example, the automobile required the proliferation of gas stations to refuel. Similarly, the computer required software to support its uses and subsequently the digital communication network embodied in the Internet.

2.2 Implementation

Networks developed around both the automobile and the laptop computer to make them more useful. In the first case the development of national, limited access, high speed highways provided a system to allow automobiles to compete with intercity trains which was initially developed in Germany, not surprisingly, as the automobile owes much of its present form to the inventions and subsequent organization of Benz and Daimler. The United States later mimicked these transportation networks following World War II with its interstate system, wrapping the project in national strategy and defense goals.

The development of highways paralleled the increased reliability, range, and speed of the automobile coupled with the establishing of supporting services for fueling and repair. Local roads and shorter trips were supplemented by the higher speed, greater distance highways. In the 1920s, standardization of highway construction with lane widths, shoulders, and banked curves occurred. This is in contrast to the computing networks where standardization preceded the build out of the network.

The computer network, frequently referred to as the “Information Superhighway” through the nineties, was popularized by analogy to the highway network. In contrast to the highway network, the computer network accessible to laptop computers developed more rapidly. Three factors seemed to have influenced this development. First, there was the existing time-share model that linked terminals to a mainframe, similar to a local road. Secondly, a number of local networks, frequently using incompatible standards such as Novell Netware, IBM TokenRing, or Apple Local Talk/Phone Net all yielded to the TCP/IP protocol, an open standard available for adoption by all parties. Finally, the initial connection to wide area networks used the telephone system, a pre-existing network that itself was in transition from an analog to digital network.
2.3 Process

While the automobile might not have introduced the factory system, it became associated with the mode of production. This included standardized design, the ability to manufacture interchangeable parts with sufficient tolerance for assembly, and the ability to manage component suppliers, whether internal or externally contracted. The factory design was fixed. An external agent determined the flow of material and the design of the line. There was little chance for a dynamic system that could adapt to changing circumstances. This was deliberate as change was designed out of the system with an expectation of standard parts. This model of production reigned toward the end of the century when it became more flexible with just-in-time and other models (Fukishima and Yamaguchi, 2009).

In contrast, the designs that exploit the strength of the digital revolution are surprisingly flexible. For example, the Honeywell and the Nest thermometer look surprisingly similar, both are round, with a large central dial. The Honeywell has a typical analog scale while the Nest has a digital readout. The similarities end there, however. The Nest is a programmable thermometer which, rather than being explicitly programmed, learns the patterns of the household, as well as being able to modulate according to occupancy and the weather (Nest, 2012). As both a programmable device and a wireless communicating device, it can not only monitor local parameters but use external data. More interestingly, the installed Nest thermometers form a network. This has allowed the system of thermometers to better monitor patterns across a larger swath of users. Results of the first year installation led to software upgrades that better anticipate user habits.

3. CONCLUSION

The 20th century saw great changes with the development of the automobile and its democratizing land travel. People could now drive themselves where they wanted to go on their schedules. The computer revolution that characterizes the 21st century similarly democratized information. Now people could use information to control their environments. Through artifact, implementation, and process we can compare these two dissimilar times.

REFERENCES


Posters
INTELLIGENT CLASSROOM INFORMATION SYSTEM USING SENSING DATA AND PERSONAL RECORDS

Masaki Fujisawa*, Hiroshi Sugimura**, Hiroto Hoshino* and Kazunori Matsumoto*
Department of Information and Computer Sciences, Kanagawa Institute of Technology *
Smart House Research Center, Kanagawa Institute of Technology **
1030 Shimo-Ogino, Atsugi, Kanagawa, JAPAN

ABSTRACT

The final purpose of this study is a development of an intelligent information system that activates useful interactions and increases mutual understanding in a classroom. For this purpose there necessary to use personal data of students such as histories of examination performances, lists of favorite and poor subjects, records of homework assignments, etc. In addition to these kinds of statistic information, we emphasize a need of dynamic and real-time information such as change of concentration degree to the lecture in a current classroom. In order to realize this idea, we need an automatic estimation mechanism of student behaviors and concentration degrees based on a real-time monitoring in the room or students. Several studies in educational engineering propose specially designed monitoring devices for a similar purpose. Most of these devices are fixed in the room and cost too much. We need a more flexible method for daily classrooms. Therefore this study uses the usual smart phones as a practical tool for carrying out this purpose. We in this paper, as the first step to the final purpose, show how to use the collected information through smart phones.

KEYWORDS
Educational engineering, classroom information system, activity recognition, smart phones

1. INTRODUCTION

Intelligent information systems are effective in classroom education. In the field of education engineering, lecture support systems that can integrate types of information. The main information dealt with in those systems statistic, principally performance records of past student activities. In general to know the current situation of students requires special devices such as response analyzers, which have been studies and been developed in some decades. The ability of traditional analyzers is restricted and insufficient for more intelligent purpose; data used in the system are collected through student operations that are invoked instructions of a teacher, which are conscious mind activities. We need a tool that can measure subconscious level situation of students. Some recent studies use portable electroencephalographs, that are compact and similar to usual music headphones. It is however painful experience to wear such devices all the time in a lecture so that the approach is not practical in daily classroom.

Smartphones are rapidly spreading and now most of university students have them in their possession. A smartphone equips several kinds of sensors including an accelerometer and of course has an ability of transmitting sensing data through a Wi-Fi wireless network or by using a public data line. In many cases students hold smartphones inside their pockets of jackets, shirts or trousers. The weight of typical smartphones is very light so that they become somewhat a part of body and students wear them with almost every time. Based on these observations, we develop a first experimental system using smart phones, where Figure 1 shows an example of a use of them.

Sensing data with smartphones in a classroom are sent to the data server, which centrally collects all relating information of students in the classroom. A method of activity recognition is applied to estimate a current situation of the classroom, whose precision of the estimation is not sufficient for understanding behaviors of students. In particular, the precision decreases for estimating a behavior that continues relatively a long time interval. We then use the personal historical records of a student to compensate the recognition approach. These sensing data and personal data are also used to judge the entire situation of a classroom.
2. SYSTEM OUTLINE

Figure 2 shows an outline of the proposed system. Each student has his/her own smartphone $S_i$, of which sensing data is gathered into the server $V$. The activity recognition module $A$ estimates current situation of each student and also that of the entire classroom. The estimated results are displayed in the teacher console $T$ in real-time manner. ‘Concentration of student $S_j$ is decreasing’ or ‘Classroom is becoming loose’ is an example in $T$. For each student and the entire classroom, other useful information is retrieved from the student records $R$, which is also shown in $T$. In the task of recognition, the $A$ refers to the pattern base $P$ which stores useful features to distinguish different situations, and to the student records base $R$ which stores historical records for each student. The pattern base $P$ is prepared by using machine learning technologies in the machine learning device $M$. The performance of $A$ is increased with a use of $P$ and $R$.

3. ACTIVITY RECOGNITION AND OTHER FUNCTIONS

We first define five naive activities of a student (1) reading, (2) writing, (3) typing, (4) moving, (5) sleeping. Based on these naive activities, we define two situations of a student; being concentrating and being loose. The naive activities are determined in every 5 seconds, while the situations of a student are determined in longer time interval with every 5 minutes. The classroom activities can be determined by the majority rule, if great number of students is concentrating then the entire classroom is estimated to be a good concentrated situation. In accordance with the individually or entirely estimated situation, this system can send warning messages to loose students. The naive activities are recognized by using sensing data with a smartphone.

In the case of activity recognition, we prepare template data for each naive activity. The sensing patterns of different persons are similar from many points of view but they are not the same. Thus activity recognition requires data mining technologies of time-series data. Figure 3 shows the patterns for an activity taken from 15 different persons. We collect enough numbers of typical patterns for every naive pattern, and then they are separated into groups by using clustering technique.
After identifying the pattern clusters for each activity, we construct a decision tree to recognize a given sensing data. Each of the smartphone used here is sending data in real-time, thus we cut the data having 5 seconds length using slide-window method (Esling, 2012). The construction of the tree is not straightforward but we omit the detail explanation here. A concentration degree is determined in a long time interval, then we calculate a score for the long interval based on recognitions on every 5 seconds. Historical records for students are used here to increase the precision of recognitions. For example if a student has a record to get excellent scores in similar lectures, the recognizer receive bias for the good situation over the lectures.

4. CONCLUSION

As a first step towards multi-resources intelligent classroom information system, we in this paper explain the activity recognition part that works over sensing data obtained by smartphones. For each student current situation is estimated in accordance with the five naive activities that end in short time intervals. Based on the estimations and other information, we estimate classroom situation. Classes in university often have more than a hundred of students so that professors have difficulty in observing students and understanding atmosphere the classes. By using this system, the degree of concentration or interestingness to the lecture can be estimated real-time manner; this information is useful for the teacher to improve the lecture. This paper shows only an overview of the system, we will explain more in detail at the conference.

REFERENCES

TIME-SERIES DATAMINING SYSTEM
WITH ANNOTATED INFORMATION

Hiroto Hoshino*, Hiroshi Sugimura** and Kazunori Matsumoto*

Department of Information and Computer Sciences, Kanagawa Institute of Technology *
Smart House Research Center, Kanagawa Institute of Technology **
1030 Shimo-Ogino, Atsugi, Kanagawa, JAPAN

ABSTRACT
The purpose of this study is a development of a flexible datamining system which exploits mainly over numerical time-series data. The first step of this task requires processing of data from various points of view. For this purpose we develop time-series manipulation language TQL, which can operate over patterns in time-series data. We show an outline of the language. Another point of this study is a use of annotated information, which is obtained semi-automatically from the Web space. In most cases data, on which we carry out datamining, have back ground information. We propose a mechanism to search related short text information, which is called annotations, against specified points or intervals of time-series data. We show a method that carries out datamining with collected annotations.

KEYWORDS
Data mining, annotation, meta data, knowledge engineering, query language

1. INTRODUCTION
This paper proposes a system that datamines knowledge to extrapolate future behaviors of time-series data. As shown in Figure 1, the datamining process consists of several different tasks (Han, 2012). In these tasks, necessary data, collected interactively from databases, are preprocessed and are transformed into knowledge. We need a data manipulation and query mechanism for this purpose. In the case of time-series data, the standard database query language SQL is insufficient, thus we develop an extended query language, which is named Time-series Query Language, TQL for short. Another important purpose in the data transformation task is to find a compact set of features (Esling, 2012) that can identify essential parts of data. In general, discovery of features becomes a crucial problem depending on human experts’ knowledge. Another unique point of this study is a use of annotations, which is a kind of meta-data attached over original data. Most of time-series data have its back ground implicit information, but such information is not expressed in the data itself. Annotation is a possible way to transform implicit information into explicit expression. In this study, we restrict the scope of time-series to financial area, typically daily stock price data. Most of publicly traded companies disclose their information over the Web space. Then we develop a system that automatically collects such open information for each company, and convert it into annotations. With the collected annotations, we apply an extended datamining method of association rules to discover knowledge.
2. QUERY LANGUAGE AND ANNOTATIONS

In order to carry out a datamining process efficiently, we develop query languages TQL over time-series data. This language deals with patterns of time-series, and a combination of patterns can be specified by using a way similar to the regular expression. Types of connection patterns with logical connectives can be specified with the language. A user of our system repeatedly and interactively uses TQL to find useful features from data. We also implement the matching algorithm (Ding, 2008) that deals with ambiguity among patterns. Similar patterns that are not exactly the same but have enough similarities can be treated as the same pattern, this function is important in time-series datamining. Degree of similarities is defined several parameters in the algorithm, and they are also specified by using TQL.

<table>
<thead>
<tr>
<th>Query ::= Path</th>
<th>Path Op Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path ::= Pattern</td>
<td>Pattern &quot;/&quot; Path</td>
</tr>
<tr>
<td>Pattern ::= String</td>
<td>wildcard +</td>
</tr>
<tr>
<td>Op ::= &quot;and&quot;</td>
<td>&quot;or&quot;</td>
</tr>
<tr>
<td>Wildcard ::= Refer to Table 2</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Wildcard and Quantification

<table>
<thead>
<tr>
<th>Wildcard</th>
</tr>
</thead>
<tbody>
<tr>
<td>{n,m} Matches the preceding element at least m and not more than n times</td>
</tr>
</tbody>
</table>

Intuitive image of annotations is shown in Figure 3. Stock prices change day by day, in many cases the change of price can be explained by a set of short keywords. For example, a sudden stock price decrease of a company may be brought by an announcement of a competitor’s new product. The announcement becomes the explanation. On the other hand, good news for the company, promotion a fine product forestalling others, may increase the price. These are examples of possible short explanations. We remark here there are two types of explanations, the first one is set to a specific time point and the other is set on an interval of time. We call the former type is news, and the latter one is event. We develop a semi-automatic annotation system that runs over the Web space, which outline is shown in Figure 3.  The basic idea here is to use a pre-defined knowledge base to focus on a subset of Web pages. For a give company we can list up Web sites that provide useful and effective information for the company. With the sites in the list, we extract text information and collect essential keywords using standard text processing technologies, and then we identify a small set of keywords as annotations. If a keyword expresses an activity which continues some interval of time, then it becomes the event type, otherwise it has no duration and has no activity then it is the news type. The determination is also accomplished with a knowledge base which stores ontological information of keywords.

After identifying sets of annotations and their types, we carry out datamining basically based on an association rule mining method as follows. The idea of influential distance is essential here.

1. Extracting features patterns of time-series data,
2. For each feature pattern and each annotation, compute their influential distance. Annotations having grater influential distance are called effective annotations for the pattern, and
3. Using effective annotations, we transform them into association rules, which are called annotated association rules. Examples of them are shown in Figure 4.
3. CONCLUSION

The final purpose of this study is a proposal of flexible and powerful datamining system runs over numerical time-series data with augmented annotations. Towards a first step to the goal, we in this paper show an idea of TQL, which is useful in pre-processing phase. Another contribution of this paper is a proposal of annotations and annotated association rules. Annotation is a kind of meta-data which express implicit background relevant information by a keyword. In order to collect annotations semi-automatically, we propose a special type of Web crawling system with relating URL knowledge and vocabulary knowledge. It searches the Web space with the restrictions defined in the knowledge base and finds candidates of annotations. In the experiments, we use daily stock price data for companies and collect annotations using the above semi-automatic way. Both data are mixed together and converted into annotated association rules. In this case, we use influential distance measure to focus on useful subset of annotations. These rules can be seen a result of hybrid datamining. Experimental results and details of algorithms, including the applicability and precision of the discovered rules, will be shown in the demonstration at the conference.

REFERENCES

IMPROVING THE SECURITY OF MOBILE CLOUD USING BIOMETRIC AUTHENTICATION (ISMCBA)

Iehab ALRassan and Hanan AlShaher
Department of Computer Science, KSU - Riyadh, KSA

ABSTRACT
Mobile cloud allows mobile users to access and manage data anywhere and anytime using mobile devices. Mobile devices have the advantages of taking data out of homes and offices and putting them in users' pockets. Due to the limitations on the hardware of mobile devices, which cannot install and run full software features such as Microsoft Office or Adobe Photoshop, cloud computing will be the future solution of mobile computing, giving users more computing power and capabilities beyond the limitations of mobile devices. The combination of cloud computing and mobile computing produces mobile cloud computing, which also presents added security concerns such as unauthorized access of resources. This paper introduces the fingerprint recognition system for user authentication using the built-in camera of mobile phones. The proposed solution captures the fingerprint image and extracted features by preprocessing the samples. Then, the image is stored in the database for comparison purposes to verify the identity of the user, allowing them to access mobile cloud computing as a part of enhanced mobile cloud computing security.

KEYWORDS
Mobile phone; Camera; Biometric; Fingerprint.

1. INTRODUCTION
Portability is an added value to computer devices which everyone seeks, either at work or at home, with the preservation of the processing power and local data storage. This is illustrated in the growth of the number of laptop users over PCs users, and that is why the functionality of the mobile phone has been changed.

Initially, the basic function of the mobile phone entailed being able to make phone calls, but nowadays that is not enough and it is a secondary function since everybody wants to browse the Internet and do much more [1] [10].

The ability to access your data from anywhere and anytime at a low cost are big benefits of mobile cloud computing. But while also making the data portable, you may worry if your data is on the cloud and wonder if there is any unauthorized access. The primary security issue on mobile cloud computing is access to data; because while authorized users can access the data, the cloud provider can do so as well. Also, unauthorized access by third parties can occur, such as hackers. So the security issue in mobile cloud computing is a priority for researchers [9, 13].

In traditional cloud computing, we can avoid this problem by simply encrypting data before sending and storing it in the cloud. But we know that for the mobile user, the encryption technology is not suitable because performance would suffer due to the high workload required by encryption processing. Therefore, we must consider performance when designing security solutions for the mobile cloud [13].

We will present an approach for an authentication system by using fingerprint recognition as a part of our security solution. Improved access to the mobile cloud requires improved security which at least protects the mobile cloud from unauthorized access. This section started with a brief introduction of mobile cloud computing. The remainder of the paper is organized as follows. Section 2 describes the concept of mobile cloud computing. In section 3, we provide the literature review and present our approach. Finally, the conclusion is given in section 4.
2. BACKGROUND

2.1 Mobile Cloud Computing

Data will be available not only at home or at the office, but it can easily been accessed from the cloud with a mobile device and be managed from anywhere. Mobile devices take data out of homes and offices and put them in our pockets. However, due to the limitation on the hardware of these devices, they cannot fully install and run software such as Microsoft Office or Adobe Photoshop. As an alternative, cloud computing will be the future of mobile computing that has computing power. Indeed, accessing the cloud with a mobile device engenders a new concept called Mobile Cloud Computing (MCC) [1].

The Mobile Cloud Computing Forum defines Mobile Cloud Computing (MCC) as follows: “Mobile Cloud Computing refers to an infrastructure where data processing and storage happen outside of the mobile device” [3]. At any rate, despite the advantages provided by mobile cloud computing, security still remains an important issue [10].

2.2 Security in the Cloud

Without a secure environment, no one would be inclined to move to cloud computing. Security concerns exist both for customers and cloud providers. But as some published reports indicate, security concerns are not considered the top priority for cloud providers when they provide the services. But from the customer side, security is at the top [7].

There are many levels of security in cloud computing (Infrastructure security, Data security and Identity and access management –Authentication, Authorization and Auditing) [5] [7]. We will focus on identity and access management, especially regarding authentication.

The basic function to secure cloud computing is identity management and access control. One of the benefits of identity management is keeping your data safe from unauthorized access [5]. User IDs and passwords are a universal and simple means of identity management required to log in to a system. Yet in the cloud, security should be more robust than that and utilize technology such as smart cards or biometrics [7].

3. DESIGN APPROACH

Biometry appears to be a good solution to increase security levels [11]. Especially in mobile phones, they will be common in the near future. Recently, there are a few works which use the digital camera or a webcam as a sensor, but this is only in the literature. Embedding a special fingerprint sensor or adding external hardware such as a fingerprint reader will be costly and impact the mobile device’s simplicity [8].

3.1 Related Works

There are a few research studies being done to extract fingerprint images from a digital camera. [2] presented a preprocessing approach for fingerprint recognition.

In [12], they present fingerprint image preprocessing approaches based on a whole-hand image captured by a digital camera. This method starts with locating a key point location from the hand contour image. Then, the middle finger is segmented from the hand image to extract the fingerprint from it.

The feature extraction is based on the region growing method, frequency information and color distribution information, in [8], and then they apply an iterative robust regression method to do orientation estimation. In [4], the segmentation is done by skin color detection, then enhanced by using the Short Time Fourier Transform analysis; after that the core point is detected.
3.2 How to Work

We present a fingerprint recognition system which uses a mobile phone camera. Fingertip images are different than the fingerprint images. In this paper, we obtained the fingerprint image on the fingertip image since our sensor is a mobile camera. So the fingerprint image varies from fingerprint sensors which contain the surrounding environment of the finger. This difference led to variation in the image quality [6]. So, preprocessing for the fingertip image is important.

Preprocessing is a sequence of steps to export the fingerprint feature extraction, which includes pre-filtering, segmentation, enhancement and core point detection until matching [2]. The aim is to convert the fingertip image obtained by mobile phone camera to a fingerprint image and extract the ridge structure from it to be as similar as possible with the ridge structure obtained from a fingerprint sensor. Of course, we cannot convert the image to be like the output image obtained and processed by using fingerprint sensors; but at least we aim to export an acceptable output [11].

Initially, in the enrolment phase, the user presents their fingertip to the mobile phone camera to obtain a fingerprint sample and extract features by preprocessing the sample. Then it is stored in the database for purposes of comparison to verify the identity of the user.

3.3 Valuable of Approach

The added value in this approach is in the expanded preprocessing steps, which is the preprocessing steps on the fingerprint image obtained by using sensors or by using digital cameras, which mainly is segmentation. But in this approach, we convert RGB to gray-scale image, normalization, reduce the blur effect, segmentation, orientation estimation and ridge enhancement. The other steps are combined from many approaches and the aim of this combination is to get the best result for matching.

3.4 Preprocessing Steps

From related works, we expanded the preprocessing steps as follow:

1. The input image is obtained by using the built-in mobile phone camera.
2. In a fingerprint sensor, the input image is in gray-scale format. So we need to convert the RGB image obtained by the mobile phone camera to gray-scale format before preprocessing [4].
3. As in the experiment in [4], if the gray-scale image is directly enhanced without normalization, the result of core point detection will be unsatisfactory due to the non-uniform lighting problem in the image. So we need to first complete the normalization, which minimizes the non-uniform lighting problem.
4. If the finger is moving or the focusing of the lens is bad when capturing the fingertip using the camera, then image will have a blur effect. So we need to reduce the blur effect in preprocessing modules due to the effect it has on the feature extraction step [6].
5. The fingerprint image obtained by the mobile phone camera is not free from unwanted surrounding background. So we need to remove the background; this process is called segmentation. Also, it is important for minutiae extraction to generate accurate minutiae. Without subtracting the background, generated minutiae will be wrong [6, 4].
6. The image produced by webcams or low-cost cameras has different scale, rotation and position. So we need operations to scale and rotate the fingertip image. These operations are called registration or fingerprint orientation estimation. Its aim is to put the image in standard format, which is the center of the image as the center of the fingertip and the orientation must be horizontal [9, 4].
7. In the fingerprint sensor, post-processing is done to enhance the ridges. But in the fingerprint image captured by a mobile phone camera, we need to extract and enhance the ridge due to the ridge being hidden on the color image. The reason for the need to emphasize the ridge is because it provides crucial information for feature extraction and then recognition purposes [6].
8. Core points have different positions for each fingerprint, so it is important to determine an accurate and reliable core point because fingerprint testing may be cancelled if core point detection was wrong [6, 4].
9. The features are a fingerprint minutia, which is extracted from the mobile phone camera image, yielding an output image from preprocessing steps that can be used as input to matching algorithm [11].
4. CONCLUSION

The combination of cloud computing and mobile computing produces mobile cloud computing, and also introduces security issues such as unauthorized access. Therefore, a proposed solution should be considered to protect mobile cloud users from these security threats. In this paper, we focused on the mobile cloud and security as concepts. Then we discussed the current state of mobile cloud authentication technology and covered some of the technologies that exist and are in use in the real world.

Biometric recognition will be prevalent in the near future in mobile devices. Thus, we presented our authentication system by using the camera of the mobile device as a fingerprint sensor to obtain a fingerprint image and recognize it. Our approach is an extension and combination of related works on web cameras or mobile cameras. In addition, our approach has added value to keep performance at an acceptable level.

For future work, we will be using logs that will help to identify unauthorized attempts to access data by third parties – the cloud provider or any hackers. Based on these logs, we can create and modify our cloud security policies.

REFERENCES

VISUAL EXPLORATIVE INTERFACES FOR THE ACM DIGITAL LIBRARY

Xia Lin¹, Mi Zhang¹, Haozhen Zhao¹ and Jan Buzydlowski²

¹College of Information Science and Technology - Drexel University - 3141 Chestnut Street, Philadelphia, PA 19104 USA
²School of Business Administration - Holy Family University - 9801 Frankford Avenue, Philadelphia, PA 19114 USA

ABSTRACT

This paper presents two interactive visual interfaces that take advantages of both the hierarchical and semantic relationships of terms in the ACM Classification System to help users navigate and explore the ACM digital library. The interfaces show that much can be gained by integrating the dynamic statistical patterns and static hierarchical structures of the classification terms to provide better overviews and navigational guides to the digital library.

KEYWORDS

Visual Interface Design; Information Visualization; Classification Systems; Interactive Exploratory interface.

1. AN EXPLORATIVE INTERFACE FOR THE ACM CLASSIFICATION SYSTEM

The objective of this paper is to present two interactive visual interfaces that take advantages of both the hierarchical and semantic relationships of terms in the ACM Classification System to help users navigate the ACM conceptual space and digital library. While similar analysis has been done in some other research (Speretta & Lakkaraju, 2010; Osinska, & Bala, 2010), our interfaces are unique in integrating the two types of relationships in a browsing and searching interface.

The first interface is to let users explore term relationships of ACM classification terms. The ACM Classification System includes a hierarchical tree of three levels of coded concepts or categories plus a fourth level of uncoded subject descriptors. Traditionally, term relationships in the classification system are only defined in the hierarchical structure. There are little associative or semantic relationships in the classification system. Now, in the digital environment, as the Classification System is fully integrated with the ACM digital library, more term relationships can be extracted and analyzed from document collections in the digital library. The statistical analysis of how the classification terms are selected for indexing by actual users and how the terms are used together to index documents has become a useful associative relationships of the terms that should be added to the Classification System and made available to the users when they need to select terms for indexing or exploring related terms. That is what we try to accomplish through the interface.

A motivation for the interface is to help users quickly find appropriate subject terms when they author a new paper. When an author considers one subject term, what other subject terms he or she should also consider? The interface (Figure 1) helps to answer such a question quickly. The interface includes the hierarchical relationships of the terms on the left-hand side where the user can go up and down the hierarchical tree to look for subject terms based on the hierarchical relationships. When the user clicks on a term on the tree, an associative map will be generated in the main area to show how the top 25 most co-occurred subject terms are related to each other. The associative map, generated by the PathFinder algorithm (Schvaneveldt, 1990), helps the user find related subject terms under different categories that might be difficult to identify with the hierarchical structure only.
A unique feature of the interface is to couple closely the hierarchical list of the terms and the associative maps. The user can choose to browse either one of them or jump from one to another. When the user moves the mouse over a subject term on the map, the term and its location on the hierarchical list will be identified and highlighted. The user can also click on a (graphic) node of a subject term to generate a new associative map for the clicked term, or click on the term itself to show all the children terms of the clicked term.

Many other interactive functions are implemented to support user’s browsing and exploration of the classification system. Currently we are running experiments to test how users can use the interface to find subject terms quickly, identify relevant terms of a concept, and modify queries based on the hierarchical and associative maps. As the interface continues evolving, we will include other visual views to create an integrated interface for effective use of the classification system. We believe that such an interface will provide a new way for the user to understand and utilize the classification system for searching and browsing the ACM digital library.

2. AN ASSOCIATIVE MAP INTERFACE FOR THE ACM DIGITAL LIBRARY

The second interface we developed is to test how well the combined hierarchical and associative relationships of the subject terms can be applied to guide users in searching and exploring the ACM Digital Library. Figure 2 shows an example of the interface developed with the Adobe’s Flex technologies. With this interface, the user can start a search with any free text query. The interface sends the query directly to the ACM digital library through its public APIs. The results returned by the digital library is extracted and analyzed by the interface, with both titles of relevant documents and subject terms displayed. When the user moves the mouse over a title, the detailed information of the document will emerge in a pop-up window.

A key feature of the interface is to offer users multiple ways of exploring and filtering the search results. Through the interface, users can interact with both the hierarchical and associative displays of the subject terms to explore their relationships. The users then can click on a relevant subject term on either displays; the term will be automatically added to the query to narrow down the search results.

It was found that the hierarchical display and the associative display often offer different perspectives to the search results. Terms closely displayed on the associative display often belong to different branches in the hierarchy. This creates connections that otherwise would be difficult to see by the hierarchical structure alone.

We plan to compare this interface to the standard Web interface of the ACM Digital Library. We believe that the integration of hierarchical and associative displays will provide new overviews and navigational guides to users when they need to conduct exploratory searches in some unfamiliar topical territories.
3. CONCLUSION

In this research, we studied how to make better use of a traditional classification system such as the ACM CCS in the digital environment. We applied several methods to analyze the features and characteristics of the classification system. Based on the analysis, we created two visual interfaces that integrate hierarchical and associative displays of subject terms and documents to help users to explore concept relationships and conduct exploratory searches in a digital library.

More research is needed to develop principles and methods for the integration of classification systems, controlled vocabularies, and ontologies to digital libraries. Of particular interest is how to create effective visualization interfaces to link vocabulary tools dynamically with digital collections. Results of this research will help to move toward this direction.

ACKNOWLEDGEMENT

This work is partially supported by NSF Award No. 0935942 and by IMLS doctoral fellowships. Our thanks to ACM and Professor Lillian Cassel of Villanova University for making the data available for this research.

REFERENCES

ABSTRACT
The NFC fitness guide, which is part of a larger NFC multi-service field trial, consists of three distinct parts: The visual parts for users of the system, the generic backend logging system, and the fitness guide web server. The visual parts of the service are the anatomic smart-poster with interactive smart-tags as well as smart-tags placed on exercise equipment in the gym. The generic backend logs all NFC smart-tag user interaction (used for other NFC services in the multi-trial). The fitness guide web server is a content management system for exercise related information and consists of the dynamic pages served to end users (on their mobile phones) and an administrative content management service.

KEYWORDS
NFC, smart-poster, fitness, content management system.

1. DESCRIPTION
This poster presents one of several services – the NFC fitness guide – included in the ongoing NFC City innovation project (Andersen et al., 2011). The objective of the main project is to promote development and use of services for information exchange, physical access, ticketing and payment through new applications of mobile and Near Field Communication (NFC) technologies. NFC is a short range wireless technology that promises to simplify the interaction between users and tasks in a given physical environment (Ailisto et al., 2007; Evjemo & Akselsen, 2011; Medaglia et al., 2011). The multi-service field trial is using a mixed method approach and is conducted at a university campus, including 50 test users (students) equipped with NFC-enabled Samsung Galaxy SIII smart phones.
The NFC fitness guide consists of three distinct parts (figure 1): The visual parts for users of the system, the generic backend usage logging system and the fitness guide web server. The visual parts of the service are the anatomic smart-poster with smart-tags that allows users to interact with the service using NFC-phones, as well as smart-tags placed on exercise equipment in the gym. The generic backend logs all usage (NFC smart-tag interaction) including when and who actually touched the tag. The generic backend is a reusable component, also used for other NFC services in the NFC City multi-trial. The fitness guide web service is a content management system for exercise-related information and consists of the dynamic pages served to end users and an administrative content management service that allows trainers, physiotherapists and diet experts, etc. to add information to the system.

A use case: Anna, a student, enters the gym. She is ready for more serious work-out programs. She turns to the fitness guide poster and touches the label placed at the muscle figure’s leg – with her phone. A video is immediately shown on her phone screen presenting some exercises that fit her needs.

The conference poster is formed as an interactive NFC smart-poster that illustrates the fitness guide service in full and in addition contains tag points including extra information and videos that have been prepared to illustrate all the services included in the NFC multi-trial project. The NFC smart-tags on the poster will be accessible to all conference participants that have NFC-enabled phones.

ACKNOWLEDGEMENT

Thanks to The Student Welfare Organization in Tromsø for contributions to the design and implementation.
REFERENCES


Doctoral Consortia
ABSTRACT
Enterprise architecture (EA) is positioned as an instrument for steering enterprise transformation. However, existing EA approaches do not cover all aspects having an impact on enterprise transformation. The existence of different organisational subcultures is not taken into account although it is considered as significant in the context of change. The alignment of business and IT plays, for instance, a major role in transformations and in EA. In this paper I introduce my research problem of exploring the impact of organisational subcultures on the EA process. As I aim at understanding a complex social phenomenon, the research techniques I use are of qualitative nature. Unstructured and semi-structured interviews with architects from multiple organisations provide a broader view on the role of subcultures in EA. In a second step, case-study research is used to zoom in on selected insights from the interviews. My first results have been aggregated in an initial conceptual model. This model indicates that communication is an intermediary variable between subcultures and the success of an EA guided enterprise transformation.

KEYWORDS
Enterprise architecture, cultural diversity, enterprise transformation, exploratory research, explanatory theory

1. INTRODUCTION
Enterprise transformations are fundamental changes within an enterprise, e.g. regarding technologies or objectives (Wagter et al. 2011, Rouse 2005). In order to be successful, such transformations need to be coordinated. Enterprise architecture (EA) is positioned as an instrument for steering transformations (Op’t Land et al. 2009). Op’t Land et al. (2009) define EA as “a coherent set of descriptions, covering a regulations-oriented, design-oriented and patterns-oriented perspective on an enterprise, which provides indicators and controls that enable the informed governance of the enterprise’s evolution and success”. By linking information systems to the rest of the enterprise (Hoogervorst 2004), EA gives a holistic view on an enterprise. It aims at supporting the design, communication and implementation of changes.

However, current EA approaches do not cover all aspects having an impact on enterprise transformation. One of the less considered, important topics within the field of EA is the existence of different organisational subcultures and its impact on the EA process. Since enterprises are socio-technical systems, organisational culture plays a major role within enterprise transformation. In this context, it is acknowledged as a factor of significant impact, e.g. regarding the interaction between different subcultures during the transformation (Rouse 2005, Detert et al. 2000, Morgan 1998). Moreover, the importance of culture for EA is emphasised by Lange (2012) who shows that culture influences the use of EA as well as the realisation of benefits from it.

The concept of organisational culture can be applied at different levels of an enterprise, i.e. for the entire enterprise or for subgroups of an enterprise (Hofstede et al. 1990, Schein 2004). My research focuses on the cultural differences of subgroups, e.g. departments, within an enterprise. For better understanding, I call the culture of a subgroup an (organisational) subculture. I suspect that differences between subcultures influence the EA process. An indication for that is given by literature on social business-IT alignment, which points out that in order to align business and IT the culture gap between these two groups has to be taken into account (Reich & Benbasat 2000, Taylor-Cummings 1998). Yet, it is not clear what the role of subcultures in EA
looks like. Therefore, the research question that is introduced in this paper is: how do the differences between organisational subcultures influence the EA process?

The remainder of this paper is structured as follows: section 2 presents some existing EA approaches and shows their limits for my purpose. Section 3 gives the reader a deeper insight into my research problem and my research approach. In section 4, I present some initial results. The paper ends with a conclusion section.

2. PREDOMINANTLY BLUE-PRINT APPROACHES IN EA

Most of the existing EA frameworks take an engineering approach towards enterprise transformation. In order to achieve change, they develop a to-be EA, the so called blueprint. They assume that change will be achieved by defining the aim and the necessary steps to get there (Wagter et al. 2011). In the following, I will briefly present two of such blueprint approaches.

The Zachman framework focuses on the modelling of an EA (Sowa & Zachman 1992). It shows how different techniques interrelate and fit together and aims at organising complex enterprise systems (Sowa & Zachman 1992, Schekkerman 2004). However, this framework does not provide details about methods and lacks guidance on its implementation (Schekkerman 2004, Buckl & Schweda 2011). In contrast, The Open Group Architecture Framework (TOGAF) is more method focused. In its Architecture Development Method it provides a way of establishing an EA (The Open Group 2009). However, TOGAF assumes that one fixed development method works successfully in every case. It does not consider any variation due to cultural aspects. The Zachman framework and TOGAF are representative of most existing EA approaches (like TEAF, FEAF, CIMOSA, ARIS or DODAF, which are not discussed due to space restrictions) as they adopt an engineering oriented approach towards change. They do not consider any influence by organisational culture.

However, there have been added more stakeholder oriented approaches to the field of EA recently. The on-going research program General Enterprise Architecture (GEA) focuses on the influence of enterprise coherence on the success of enterprise transformations (Wagter et al. 2011). Within GEA it is argued that for improving the enterprise coherence it is necessary to distinguish several perspectives from which one wants to govern the transformation (Ordina 2012). Organisational culture is seen as one of these perspectives. Lange (2012) also points out the importance of culture. He talks about enterprise architecture management (EAM) culture, which is defined as the values and norms that are preferable when using EAM (Lange 2012). In his study he looks for factors influencing the success of EAM. Regarding cultural aspects he concludes that these have a direct impact on the use of EAM and an indirect impact on the realisation of EAM benefits. Thus, his study supports the importance of considering cultural aspects within EA.

The two presented stakeholder oriented approaches both strengthen the importance of cultural aspects in the context of EA. But even though they look at the organisational culture, they ignore the existence of different organisational subcultures. Furthermore, they consider culture as just one of multiple perspectives or factors. As a result, they do not go into detail regarding the role and the shape of culture. My research, in contrast, focuses on subcultures within an enterprise and their impact on the EA process.

3. RESEARCH QUESTION AND RESEARCH APPROACH

As shown above, organisational subcultures are hardly considered by existing EA approaches. However, literature in the fields of organisational culture and change management shows that those can have a considerable impact on transformation processes (Detert et al. 2000, Morgan 1998, Rouse & Baba 2006). Subcultures can, for example, differ in terms of power structures or intra- and inter-group behaviour: one group may, for instance, work process oriented while another one focuses more on the results (Hofstede et al. 2010).

Considering that cultural diversity has an impact on enterprise transformations, I suspect that it also influences the EA process of coordinating enterprise transformations: the enterprise architect has to coordinate the key stakeholders of the transformation. Each stakeholder belongs to a certain organisational subgroup, e.g. department, which has its own culture. Cultural clashes, such as different ways of coping with change, among the subcultures are therefore likely to lead to cultural differences among the key stakeholders.
However, to the best of my knowledge this topic has not yet been researched in the area of EA. Therefore, I am conducting an exploratory study in order to answer my research question ‘How do the differences between organisational subcultures influence the EA process’. Thus, my research aims at developing an explanatory theory as described by Gregor (2006), i.e. a theory that “provides an explanation of how, why, and when things happened, relying on varying views of causality and methods for argumentation”. In order to develop this theory, I will use two different qualitative research methods: interviews and case studies. First, unstructured and semi-structured interviews with enterprise architects are conducted in order to get a broader view on their opinion about the role of subcultures in EA. These interviews serve the development and elaboration of an initial conceptual model. Thereafter, this model will be validated using case-study research, a common method for explanatory research looking at social aspects. The case-study approach is particularly suitable for understanding complex phenomena in social life, such as cultural differences in an enterprise (Yin 2003). Case studies allow investigating real-life events, which will be needed for getting a deep insight into the impact of subcultures on the EA process (Yin 2003).

As a first step, I have talked to ten senior enterprise architects. These unstructured, exploratory interviews aimed at getting more insight into an architect’s work and his/her opinion on the role of cultural diversity in the context of EA. The interviewed architects were mostly consultants. Only two of them had also worked as internal architects. Similarly, the majority were pure architects. One was also active in academia. In the interviews I pose some open questions regarding the influence of cultural diversity on an architect’s work.

4. INITIAL RESULTS

Based on the exploratory interviews and my literature review, I developed an initial conceptual model (Figure 1).

Concerning the organisational subcultures within an enterprise the architects contrast two groups: business and IT. Independently from each other, the interviewees outlined that an architect should take into account the different ways of thinking and working of business and IT. Such cultural differences would have two kinds of impact: on the one hand, architects have to adapt their communication and coordination styles to the respective stakeholder group; on the other hand, cultural differences can lead to communication difficulties between business and IT. In both cases, the architects’ answers indicate that the success of communication is an intermediary variable between subcultures and the success of the transformation.

Finally, the architects expressed that communication breakdowns or a lack of communication can lead to struggling or even failing enterprise transformations. My model therefore suggests a relation between the success of communication and the success of the EA guided enterprise transformation.

![Initial conceptual model](image)

Figure 1. Initial conceptual model: the impact of cultural diversity on the transformation success.

Besides subcultures, the architects pointed at politics as an important factor to look at in the context of EA and enterprise transformation. However, due to scoping reasons this will not be considered in my future research.

5. CONCLUSION AND FUTURE WORK

In this paper, I have outlined the first step of my on-going research of exploring the impact of organisational subcultures on the EA process. I developed my initial idea based on an extensive literature study. Most existing EA frameworks take an engineering approach and have little consideration for cultural diversity. However, literature in the fields of change management and organisational culture indicates that differences between organisational subculture can have an important impact on enterprise transformations. This leads to my initial assumption that cultural diversity within an enterprise influences the process of coordinating enterprise transformations by using EA.
Based on ten unstructured interviews, I elaborated my initial assumption and developed a first conceptual model. In this model, communication success was added as an intermediary variable. Building on the insights from the first interviews, I am currently conducting a series of semi-structured interviews with senior enterprise architects, where I zoom in on two concepts from the conceptual model: culture and communication.

ACKNOWLEDGEMENT

The author wishes to thank her daily supervisor, Sybren de Kinderen, for many stimulating discussions regarding the research topic and for his help in planning the course of the research. Furthermore, she would like to thank her supervisor, Erik Proper, for the inspiring and encouraging discussions as well as for establishing contact with senior enterprise architects. Finally, the author gives her thanks to the enterprise architects that were willing to participate in the interviews and thus gave useful insight into their work.

REFERENCES


Ordina, 2012. GEA Groeiplatform. URL: http://www.groeiplatformgea.nl [last access 2012-03-30].


NO MORE SURPRISES: TOWARDS MANAGING OPERATIONAL RISKS IN INFORMATION SYSTEMS

Vladimir Maluga
Macquarie Graduate School of Management - Sydney, Australia

ABSTRACT
This paper reports on a work-in-progress investigation into operational risks in information systems (IS). It presents provisional outcomes of the initial exploratory inquiry into IS operational risks (ISOR). The study’s contribution to the emerging ISOR theory includes: (a) analysis of complexity and agility as persistent risk factors in production IS; (b) insights into ISOR of inadequacy; and (c) examination of ISOR dimensions (work-in-progress). The study provides sound foundation to further quantitative studies aimed at tailored responses to idiosyncratic operational risks in IS.

KEYWORDS
Operational risk, information systems, qualitative inquiry.

1. INTRODUCTION
Technology-based information systems (IS) have saturated our lives. Penetrating a growing number of products and services, they are becoming a commodity resource (Carr, 2003) – much like electricity, transportation and utilities. Increasingly, organizations use IS just to remain competitive. Internet banking sites and e-stores, opened by all banks and traditional off-the-street retailers, respectively, are just two of many examples. For commodity resources, the focus of risk management is shifting inevitably towards loss control measures associated with their operations away from strategic risks of their early adoption (Carr, 2003). Indeed, Holmquist (2007) suggests that losses from operational risk events in IS may be significant. If accumulated, they will threaten the viability of the entire organization. He observes that the majority of risk events appear to be preventable using conventional risk management (RM) approaches, but these possibilities become evident only in hindsight of risk events. RM practices are ill informed. Benaroch et al (2006) and Goldstein et al (2011) concluded that risk theory fails in meeting practical needs of organizations. The information technology best practices, such as ITIL® and COBIT®, for instance, too do not inhibit risk appetite in organizations, according to anecdotal evidence and the author’s professional experience.

This research was motivated by the Basel regulatory initiative on operational risk (BCBS, 2001). It is aimed at developing cost-effective and measurable RM approaches for large production IS. The research exploratory phase was completed as a qualitative empirical investigation into IS managers’ perspective on operations risks in IS. The key outcomes of the research to date include: (a) analysis of complexity and agility as persistent risk factors in production IS; (b) insights into ISOR of inadequacy; and (c) examination of ISOR dimensions (work-in-progress). These findings provide adequate foundation for future studies.

2. ACADEMIC BACKGROUND
The initial literature exploration revealed extensive and versatile theoretical background in operational risk. However, no commonly accepted theoretical conceptualization of ISOR was identified in the extant risk and ISOR literature. Consequently, this study adopted only fundamental notions and definition from the most relevant three theoretical domains: risk theory, IS theory and operational risk literature. This section briefly outlines the research background. The literature review continued during the analysis of the research data. It
was found that the outcomes of the study are aligned in principle with the body of work by Benaroch et al (2006), Goldstein et al (2011), and Benaroch and Chernobai (2012), which discussed later in the paper.

Risk evaluation is an essential RM activity; the task, however, is not easily fulfilled in the case of ISOR. Traditionally, risks are assessed by impact of the corresponding harmful events and the likelihood of these events (OECD, 2002). There is no consistent and effective way to establish ISOR impacts or probability – mainly due to the idiosyncratic nature of these risks (Goldstein et al, 2011). Using some form of balanced scorecards or impact assessment tools appear to be the most prevalent methods of ISOR evaluation. It is conceivable that majority, if not all, risk events in IS operations, their consequences and likelihood can be identified. However, such approach is hardly productive in complex and agile IS operations – inevitably, it is time and resource consuming. Evaluating ISOR in terms of losses appears as a more practical proposition.

The operational risk definition adopted in the study was drawn from The Basel Capital Accord regulatory framework (BCBS, 2001), commonly referred to as Basel. The Basel definition has become a de-facto standard in OR literature. It was slightly modified for the purposes of this research. ISOR were defined as risks of losses resulting from inadequate or failed internal processes, people and technologies [VM – systems in Basel documents] or from external events. Two types of operational risk – risk of a failure and risk of an inadequacy – are identified in the ISOR definition. The extant risk literature offers rich background for both types of risk. Business continuity and disaster recovery sources comprehensively examine risks of failure, while risks of inadequacy are explored in numerous resilience, reliability and mindfulness studies. However, there is an evident lack of academic literature offering practical approaches to management either of the two ISOR types (Benaroch et al, 2006; Butler and Gray, 2006; Holmquist, 2007; Goldstein et al, 2011).

The likelihood of random and rarely repeatable ISOR events is hard to assess. Without historical accounts of risk events being readily available, evaluation of ISOR probability becomes a matter of an assessor’s expertise, a perspective taken on IS, and their tacit knowledge of the IS and its operating environment. Indeed, Orlikowski and Iacono (2001) identified 14 specific conceptualizations of information technology (IT). Each one of them determines a particular perspective on IS, which, in turn, defines risks within that perspective. In this study, IS were assumed in terms of their ‘ensemble’ conceptualization (Orlikowski and Iacono, 2001, p.122), where IS represent a cohesive entity of infrastructure components, people, who use and operate IS, and processes that determine the way people use the technologies.

3. METHODOLOGY CONSIDERATIONS

Operational risks in production IS were explored in a purposefully designed qualitative study that was informed by the Grounded Theory principles (Pearse, 2005) and aimed at anchoring theoretical discourse in empirical evidence. The investigation was designed as a collective case study (CCS) ensuring its focus on the ISOR phenomena overall rather than on specific risk experiences of individual research cases (Stake, 2005). Managers responsible for IS operations, their professional experiences and perceptions of risks, have become cases in this research. This category of IS stakeholders is broadly regarded as an authoritative source of information about IS operations. The participants were selected based on predefined criteria ensuring maximum variance in their demographic, job and organizational characteristics, as prescribed by the CCS methodology. The sample includes IS professionals representing different organizations, industries, levels of management, age groups, gender and education. A broadcaster (5 participants), bank (1 participant) and government departments (1 participant) were represented in the study. The variance in the number of participants from different organizations is deliberate. The broadcaster participants provided variance within a single organization, whereas executives from The Bank and the government Agency added inter-organizational variance to the sample.

The research data were acquired using in-depth interviewing technique seeking ‘"deep" information and knowledge’ (Johnson, 2002), with particular attention given to the cases’ activities (Stake, 2005). All interviews took place at the participants’ workplaces; they were audiotaped, and notes were taken during the interviews. The audio recordings were verified within 48 hours of each interview.
4. RESEARCH DATA – USER STORIES

The research cases in this study are real people. Their identities, however, are protected by fictitious names. Any specific references and other identifying information, including names of their organizations, are either disguised or omitted. The participants represented two Asia-Pacific countries, Australia and New Zealand. They worked in three technology-intensive sectors of economy: Government – The Board, an asset management organization; Banking and Finance – The Bank, a major banking institution; and Media – The Broadcaster, a leading broadcasting institution.

The user stories reflected on the rich and diverse context of IS operations.

Brett’s is a story of a remarkable performance turnaround in The Bank’s Internet facilities: ‘If we have a problem – WE have a problem: it’s not my problem, it’s not your problem - it is OUR problem.’

Lesley’s is a story of a catastrophic outage: ‘You don’t outsource your core business.’

Samantha’s is a story of difficult relationships with business stakeholders in IS operations: ‘The most grief is caused by the systems that the users go out and purchase themselves, and then expect us to incorporate it into the network.’

Thomas’s is a story of an effective service provider: ‘My risks are high, because my costs are low.’

Olga’s is a story of tacit knowledge: ‘Losing knowledge is a big thing.’

Taylor’s is a story of an IS impact on business performance: ‘How … we manage technology effects … day-to-day business. And really that’s where a lot of the issues arise from.’

Scott’s is a story of resource deprivation: ‘It is relatively easy to get resources for [IS] projects, but there are never enough resources for support [assurance].’

5. ANALYSIS AND DISCUSSION

Theoretical sampling and constant comparison were two Grounded Theory procedures that ensured evidence based theoretical development during examination of the research data (Pearse, 2005). They guided categorization of the gathered evidence, as well as the on-going literature review.

The data analysis exposed complex composition of risks in IS operations. This complexity reflects on hierarchical interdependencies among IS components involved in dynamic interactions within fluid operating conditions, including market, business, commercial, and regulatory volatilities. The taxonomy of the ISOR context is work-in-progress in final stages of completion. The working hypothesis of ISOR evolution is being investigated; it is supported by the established risk literature.

5.1 Complexity and Agility – Two Key Risk Factors in IS Operations

Every modern IS is extremely complex (Sam) exhibiting: countless hierarchical interdependencies with other core and auxiliary systems (Thomas), processes that span the entire organization (Lesley, Sam), sophisticated varied and numerous infrastructure elements. Consequently, highly specialized skills are required for IS assurance (Olga, Scott), IS boundaries are blurred (Thomas), nobody has an end-to-end visibility of IS service delivery (Sam), operational decisions are ill-informed (Brett, Lesley), IS capabilities and business needs are misaligned (Lesley), staff isolated and demotivated (Scott), and the list goes on. Having clear accountabilities, robust processes, and well trained personnel across the entire service delivery function are natural propensities in managing complexity in IS operations. The best practices frameworks, such as ITIL®, COBIT® and Risk IT, prescribe these approaches. The best practices implementation and tailoring takes time and significant resources, and they are very successful (Lesley). However, this success is usually short-lived (Brett), due to fickle nature of IS operating conditions.

The IS operational environment is inherently agile. New requirements from customers or business, new technologies, market shifts and commercial constraints, restructuring and regulatory changes place constant pressure on established risk management metrics and controls. Maintaining adequacy of RM measures is challenging, if not an impossible objective. According to the research data, SLAs are rarely relevant (Olga), backups fail when they are needed the most (Taylor), redundancy is seldom assured (Brett), outsourcing partners have little interest in your business (Lesley), and there is never enough funding and time for training (Sam) and support provisions (Scott).
The conflict between rigidity of IS infrastructure and agility of its operating environment emerged as a principal and persistent source of risks in IS operations. Indeed, effective RM framework is normally tailored to a specific set of IS conditions, it takes time to be developed. During the RM development cycle the conditions in IS operations are likely to change making the RM establishment effort short-lived, if not irrelevant. Consequently, ISOR emerge due to the gap between RM scope and the actual IS operational conditions. Manifested initially as operational inadequacies, ISOR have tendency to aggravate into faults and, in extreme cases, catastrophic IS failures. This study empirical evidence suggests that early identification and treatment of IS operational inadequacies leads to ISOR remediation and reduction of corresponding operational losses.

5.2 Conceptualizing IS Operational Inadequacy

While organizations are doing reasonable job in treating failures, IS inadequacies, according to the research data, are persistent and loss-bearing, most of the time. All participants pointed out that catastrophic outages in mission critical IS are rare, whereas nagging issues in production IS are on-going. Considerable impact of inadequate IS services was illustrated on numerous examples: (a) slow network performance, which is particularly detrimental for on-line services, e.g. Internet banking (Brett) or e-shopping sites (Sam); (b) insufficient license provisioning for shared IS services (Thomas); (c) expensive or outdated support and maintenance contracts (Scott); (d) limited features in production applications and services (Olga); (e) applications unsuitable for established environments (Sam). The list can be easily extended. All of these issues are common in their impact on business operations – IS users, staff or customers, are unable to perform their task efficiently (or not at all), while IS remains technically in an ‘operational’ state.

The relevance of inadequacy notion of risks is supported by the recent developments in the organizational resource-based theory, and in particular, the resource weakness notion proposed by West and DeCastro (2001). The relevance of the resource weakness considerations in the ISOR context was rigorously explored and validated in Goldstein et al (2011). Indeed, for commoditized resources, with IS being one of them (Carr, 2003), their strategic value diminishes, as no longer they are unique and idiosyncratic. Strategic weaknesses of commodity resources can no longer be ignored – their relative impact increases with the erosion of the resource strategic value. Furthermore, the notion of inadequacy is well aligned with Perrow’s Normal Accident Theory (Perrow, 1984), which alignment supports the hypothesis of a possible linkage between inadequacies and failures in IS services. Brett’s case implicitly supports this hypothesis. The Bank completely eliminated outages in its Internet banking facilities by treating IS inadequacies along the entire service delivery chain.

5.3 ISOR Contextual Dimensions

The ISOR definition underscores the multidimensional nature of risks in IS operations. Not only risks in IS arise from different sources, such as technological, human, procedural, commercial; they can also be caused by external factors. ISOR dimensions identified in this study are: utility, commercial, technological, operational, social. Differentiating dimensions in an IS has important practical significance – it determines specific composition of risks in an IS and corresponding risk measures required for their treatment, i.e. risks in one dimension cannot be treated by measures inherent to another. Superior skills and extra training, for instance, cannot compensate the inferior technologies, and visa versa. Organizations should be mindful of their idiosyncratic risk compositions (Goldstein et al, 2011), in order to maintain relevance in their RM frameworks and functions.

5.4 Elements of Effective ISOR Management

Key to effective ISOR management, according to the collected evidence, is mindful collaboration among IS stakeholders. Such collaboration is essential for a number of reasons. IS complexity, specialization of support skills, sheer scale of modern IS operations lead to a large number of people involved in IS utilization and maintenance. Sharing information among all of them is not a trivial task. The agility of the IS operation conditions results in continuous changes to the established processes and communication patterns. Consequently, knowledge sharing in IS operations is not a given, it requires highly developed and deliberate
leadership skills and governance practices. The later finding is consistent with conclusions summarized in Benaroch and Chernobai (2012). Rigorous testing (Brett, Sam), proactive problem management (Lesley, Thomas), cross-skilling (Lesley, Olga) and dedicated business liaison officers (Scott, Taylor) are some of approaches adopted in participating organizations that proved to be successful in fostering collaboration in IS operations.

6. CONCLUSION

The research outcomes, and in particular, its contribution to conceptualization of the risks of inadequacy, significantly advance theoretical underpinning of risks in IS operations. Examination of the complexity-agility conflict in IS operations, as well as identification of ISOR dimensions complement theoretical contribution of this paper. Losses associated with ISOR events emerged as the most justified metric for measurable management practices. Overall, the study provides reliable foundation for further in-depth investigation into ISOR and related phenomena.

The research findings, however, are limited in scope and application. The sample under study is small and geographically bound. The ISOR taxonomy is still work-in-progress.

ACKNOWLEDGEMENT

This study is a contribution towards a PhD degree at Macquarie Graduate School of Management (MGSM). Its progress would not have been possible without mentoring and guidance provided by the research supervisor, Professor Ernest Jordan, and co-supervisor, Associate Professor Ruth Neumann. Special thank you goes to the MGSM research office staff for their effective and timely assistance.

REFERENCES


Pearse, N., 2005. Balancing Leadership Patterns To Promote Sense Of Community During Cell-Church Transitioning: A Grounded Theory Of Strategic Leadership And Change. PhD, Rhodes University, Rhodes, SA.


AUTHOR INDEX

Abanumy, A.................................327, 283
Abeyesinghe, G..............................267
Achour, F........................................199
Adachi, J......................................103
Adenuga, O.................................111
Aihara, K...................................103
Ajanovski, V.................................342
Akatsuka, H.................................103
Akselsen, S..................................337, 392
Al-Ahmad, W.................................175
Al-Aulamie, A.................................353
Aldin, L........................................3
Alenezi, A.....................................288
Al-Majed, A..................................95
Al-Oqaili, A.................................175
AL-Rassan, I.................................385
Al-Shaher, H.................................385
Alshitrri, K..................................283, 327
Alsobh, A....................................267
Amin, S......................................288
Andreica, A.................................251
Araújo, J.....................................47
Barros, R....................................256, 302
Bastos, P.....................................63
Bauer, S......................................30
Bernroeder, E...............................30
Bittner, K....................................261
Braccini, A..................................87
Brune, P......................................183
Bunker, D....................................293
Buzyladowski, J............................389
Cabral, A....................................79
Cesare, S.....................................3
Crisalli, U....................................87
Daly, H........................................353
Damasevicius, R.............................55
Marco, M....................................347
Dionysioi, I..................................239
Doukas, D....................................167
Evjemo, B.................................337, 392
Federici, T..................................87
Ferreira, J...................................79
Fujisawa, M.................................379
Fujiwara, Y..................................119
Fukazawa, Y.................................297
Gargouri, F.................................199
Gavrilaki, M.................................239
Gewald, H..................................183
Göes, A.......................................302
Gonçalves, A.................................22
Green, S......................................13
Hader, I......................................312
Hammell II, R..............................191
Hatem, P......................................307
Hisatomi, M.................................302
Ho, C.........................................151
Hori, S.......................................119
Höritz, S....................................323
Hoshino, H.................................382
Hoshino, H.................................379
Huber, S.....................................71
Ibrahim, A...................................273
Inoki, M.....................................119
Iwata, H.....................................297
Janson, M....................................127
Jedidi, A.....................................199
Jiménez, A...................................39
Jørgensen, V.................................337
Kammerer, M...............................323
Katamine, K.................................119
Kekwaletswe, R............................111, 223, 231
Kimmi, D....................................261
Kokkinaki, A.................................239
Kondo, N.....................................119
Kuboyama, T.................................332
Kühne, S.....................................278
Kurosawa, M.................................317
Kurz, M.......................................71
Lederer, M....................................71
Levy, M.......................................312
Lin, X........................................389
Magnusson, J...............................142
Maier, S.....................................323
Maluga, V....................................401
Mansour, A.................................353
Mantakas, M.................................167
Maselesele, T...............................223
Mateos, A...................................39
Mathew, S.................................207
Matsumoto, K..............................379, 382
<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mavaddat, M.</td>
<td>13</td>
</tr>
<tr>
<td>Mayhew, P.</td>
<td>95</td>
</tr>
<tr>
<td>McKenzie, W.</td>
<td>373</td>
</tr>
<tr>
<td>McQuigan, J.</td>
<td>191</td>
</tr>
<tr>
<td>Mesquita, B.</td>
<td>256, 302</td>
</tr>
<tr>
<td>Minami, T.</td>
<td>215</td>
</tr>
<tr>
<td>Miyahara, T.</td>
<td>332</td>
</tr>
<tr>
<td>Möhring, M.</td>
<td>323</td>
</tr>
<tr>
<td>Munch-Ellingsen, A.</td>
<td>337, 392</td>
</tr>
<tr>
<td>Nakai, S.</td>
<td>332</td>
</tr>
<tr>
<td>Nakatani, T.</td>
<td>119</td>
</tr>
<tr>
<td>Nakazato, R.</td>
<td>119</td>
</tr>
<tr>
<td>Niemietz, H.</td>
<td>397</td>
</tr>
<tr>
<td>Nilsson, A.</td>
<td>142</td>
</tr>
<tr>
<td>Nistad, S.</td>
<td>392</td>
</tr>
<tr>
<td>Okano, M.</td>
<td>119</td>
</tr>
<tr>
<td>Óri, D.</td>
<td>369</td>
</tr>
<tr>
<td>Pero, M.</td>
<td>278</td>
</tr>
<tr>
<td>Phurutsi, M.</td>
<td>231</td>
</tr>
<tr>
<td>Polak, P.</td>
<td>134</td>
</tr>
<tr>
<td>Ramos, P.</td>
<td>63</td>
</tr>
<tr>
<td>Rantapuska, T.</td>
<td>159</td>
</tr>
<tr>
<td>Rodrigues, A.</td>
<td>47</td>
</tr>
<tr>
<td>Rossignoli, C.</td>
<td>347</td>
</tr>
<tr>
<td>Sa, J.</td>
<td>13</td>
</tr>
<tr>
<td>Sano, T.</td>
<td>119</td>
</tr>
<tr>
<td>Sawamoto, J.</td>
<td>317</td>
</tr>
<tr>
<td>Scerbo, D.</td>
<td>87</td>
</tr>
<tr>
<td>Schmidt, R.</td>
<td>323</td>
</tr>
<tr>
<td>Scholz, S.</td>
<td>261</td>
</tr>
<tr>
<td>Schöpple, M.</td>
<td>183</td>
</tr>
<tr>
<td>Segal-Raviv, A.</td>
<td>312</td>
</tr>
<tr>
<td>Shimura, K.</td>
<td>317</td>
</tr>
<tr>
<td>Shirogane, J.</td>
<td>297</td>
</tr>
<tr>
<td>Silva, S.</td>
<td>47</td>
</tr>
<tr>
<td>Slettemeås, D.</td>
<td>337, 392</td>
</tr>
<tr>
<td>Smith, D.</td>
<td>365</td>
</tr>
<tr>
<td>Sousa, P.</td>
<td>22</td>
</tr>
<tr>
<td>Stefan, F.</td>
<td>278</td>
</tr>
<tr>
<td>Steinbacher, H.</td>
<td>361</td>
</tr>
<tr>
<td>Stuijks, V.</td>
<td>55</td>
</tr>
<tr>
<td>Sugimura, H.</td>
<td>379, 382</td>
</tr>
<tr>
<td>Sugiuichi, K.</td>
<td>297</td>
</tr>
<tr>
<td>Suppa, A.</td>
<td>347</td>
</tr>
<tr>
<td>Takasu, A.</td>
<td>103</td>
</tr>
<tr>
<td>Tsai, J.</td>
<td>151</td>
</tr>
<tr>
<td>Tsela, D.</td>
<td>231</td>
</tr>
<tr>
<td>Tsuda, M.</td>
<td>119</td>
</tr>
<tr>
<td>Tsumaki, T.</td>
<td>119</td>
</tr>
<tr>
<td>Valincius, K.</td>
<td>55</td>
</tr>
<tr>
<td>Vicente, E.</td>
<td>39</td>
</tr>
<tr>
<td>Vinodh, K.</td>
<td>207</td>
</tr>
<tr>
<td>Warlo, I.</td>
<td>261</td>
</tr>
<tr>
<td>Wieczorkowski, J.</td>
<td>134</td>
</tr>
<tr>
<td>Wolf, S.</td>
<td>337</td>
</tr>
<tr>
<td>Wolf, N.</td>
<td>323</td>
</tr>
<tr>
<td>Yajima, H.</td>
<td>317</td>
</tr>
<tr>
<td>Zacarias, M.</td>
<td>22</td>
</tr>
<tr>
<td>Zardini, A.</td>
<td>347</td>
</tr>
<tr>
<td>Zhang, M.</td>
<td>389</td>
</tr>
<tr>
<td>Zhao, H.</td>
<td>389</td>
</tr>
</tbody>
</table>